Research Report
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College of Engineering

ACCESS MANAGEMENT FOR KENTUCKY

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Access Management for Kentucky

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EXECUTIVE SUMMARY

The Access Management Manual published by the Transportation Research Board in 2003 defines access management as the "systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway[1]." The purpose of access management is to provide vehicular access to land development in a manner that preserves the safety and efficiency of the transportation system. Access management principles stress mobility for higher-class roadways and safety for lower-class roadways. An effective access management program can reduce crashes as much as 50 percent, increase roadway capacity by 23 to 45 percent, and reduce travel time and delay as much as 40 to 60 percent[2]. The benefits of access management are achieved through a series of policies that define specific guidelines and standards for allowable access levels, access spacing criteria, access permit procedures, and the means for enforcing these concepts.

All state highway agencies exercise some control over highway access, but traditionally these programs have focused primarily on driveway design and location. In Kentucky, management of highway access (at the state level) is currently limited to the Transportation Cabinet's case-by-case access permit review process for state-maintained routes and to negotiated access spacing improvements that are incorporated in the design of major highway improvement projects. Administrative regulations issued under Transportation Cabinet's authority to limit highway access define three levels of access control: fully-controlled access, partially-controlled access, and access by permit. For partially-controlled access routes the minimum spacing between access points is 1,200 feet in rural areas and 600 feet in urban areas, with an allowable reduction in the spacing of up to 15% if supported by a traffic study. For access by permit routes, additional access points may be allowed based on considerations of safety and the interest of the highway user. The Transportation Cabinet's Permits Guidance Manual provides general guidance rather than specific spacing standards for this level of access control.

At least 14 states have recently implemented comprehensive access management programs, including Colorado, Florida, Iowa, Kansas, Maine, Minnesota, Missouri, Montana, New Jersey,

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[1] *Access Management Manual.* Transportation Research Board, Washington, DC (2003).

[2] Federal Highway Administration. *Access Management, Location, and Design.* NHI Course No. 133078. S/K Transportation Consultants (April 2000).

Ohio, Oregon, South Dakota, Washington, and Wisconsin. At least four other states, including Idaho, North Carolina, Texas, and Utah, are in the process of implementing such programs. Other states are likely to change their policies to a more comprehensive approach in the near future following the release of the TRB Access Management Manual. A review of the policies of states that have implemented access management programs revealed that the key elements for a successful program are a classification system of roadways specifically for access management purposes and a set of access spacing standards and design guidelines for each class. Access spacing standards and design guidelines are typically applied in conjunction with the following management techniques: interchange area management, signalized intersection spacing, unsignalized intersection spacing, corner clearances, traversable and non-traversable medians, turning lanes, U-turns, frontage and backage roads, and provisions for alternative access.

PROPOSED KENTUCKY ACCESS MANAGEMENT PROGRAM

The essence of an access management system can be summarized in the following steps:

(1) Classification of roadways based upon functional criteria and other parameters that reflect the importance of each roadway to statewide, regional and local mobility;
(2) Definition of allowable levels of access for each road class, including criteria for the spacing of signalized and unsignalized access points;
(3) Application of appropriate geometric design criteria and traffic engineering analysis to the allowable access; and
(4) Adoption of appropriate regulations and administrative procedures.

Roadway Classification

Most of the systems developed by other states have utilized existing functional classification as the basis for their roadway classification system. The rationale for this approach is that allowable access should be correlated with a roadway's purpose and importance. Additional indicators that have been used by other states include traffic volume, speed, geometric features (number of lanes and median type), and land use. For Kentucky, it is recommended that functional classification be used in conjunction with traffic volume and posted speed limit for developing the initial access management classification system.

The proposed classification system is presented in Table-1. This system uses a set of four classes each for urban and rural roadways that do not already have full control of access. Interstates, parkways and other freeways that have full access control are treated separately and belong to two individual categories - Rural F and Urban F. The remaining classes are defined as Rural I, II, III, and IV and Urban I, II, III, and IV. The initial correspondence between functional class and these categories is: I - Principal Arterial, II - Minor Arterial, III - Collector (both Major and Minor in rural areas), and IV - Local. A speed limit of 45 mph is used in conjunction with the traffic volume ranges shown in the table to identify those roadway segments where functional class designations should be adjusted for access management purposes.

Table - 1 Use of Functional Class, Traffic Volumes and Speed Limits for Roadway Classification

Principal Arterial

Rural

Speed	Volume <5,000	Volume ≥5,000
≥45	I	I
<45	II	I

Urban

Speed	Volume <10,000	Volume ≥10,000
≥45	I	I
<45	II	I

Minor Arterial

Rural

Speed	Volume <2,500	Volume ≥2,500	Volume ≥5,000
≥45	II	II	I
<45	III	II	II

Urban

Speed	Volume <5,000	Volume ≥5,000	Volume ≥10,000
≥45	II	II	I
<45	III	II	II

Collector

Rural

Speed	Volume <2,500	Volume ≥2,500
≥45	III	II
<45	III	III

Urban

Speed	Volume <5,000	Volume ≥5,000
≥45	III	II
<45	III	III

Local

Rural	
All speeds & volumes	IV

Urban	
All speeds & volumes	IV

The proposed access classification system would be implemented in two stages. First, each state-maintained roadway segment would be assigned to one of the new classes using data contained in the Cabinet's Highway Information System (HIS) database and computerized procedures. The initial classification assignments would then be refined based on GIS mapping and a manual review process. Adjustments to the initial classifications would be made to incorporate considerations such as adjacent land use that are not in the HIS database. In order to maintain the effectiveness of the access management system, frequent and/or piecemeal changes in classification should be avoided.

Access Spacing

Spacing standards for each access classification are an integral component of access management. Table-2 shows the suggested access management spacing standards for Kentucky. It should be mentioned that the spacing distances recommended are presented in increments of 600 feet to be compatible with existing guidelines. While most states have adopted spacing standards based on fractions of a mile, i.e. 660 feet (1/8 mile), 1,320 feet (1/4 mile), etc., the spacing distances recommended for Kentucky utilize 600-foot increments in order to maximize compatibility with existing statutes (KRS 177.135) and regulations (603 KAR 5:120) pertaining to partially-controlled access highways.

In addition to the recommended access management spacing distances, a set of recommended practices that have the potential to improve flow and increase safety have also been developed. These practices include:

- An examination of the spacing distances in conjunction with sight distance requirements, which should take precedence over the recommended distances in Table-2;
- An evaluation of existing signals along reconstructed roadways to determine whether their presence is still warranted and removal of unnecessary and/or unwarranted signals;
- Encouraging corner properties with frontage on roadways with different access classes to obtain access via the lower class roadway and provision of a non-traversable median to eliminate left-turns if access must be provided along the higher class roadway;
- Locating access to corner properties as far form the intersection as possible;
- Consolidation of driveways of adjacent properties whenever feasible;
- Elimination of left-turn egress and ingress within the influence area of an intersection along undivided major highways;
- Completion of detailed studies for driveway permits within the influence area of an intersection to ensure undisturbed operations at the intersection; and

- Provision of access for outparcels at large developments from within the site and prohibition of direct access to outparcel developments.

Variance Procedure

Some flexibility is required when administering access management regulations. In conjunction with the standards that are adopted for access spacing and design, a variance or deviation process is needed to allow for lesser standards where special or unique conditions make application of the minimum standards inappropriate.

Allowing for variances in access management standards requires that these deviations be handled in a consistent manner, although deviations may be categorized as minor or major in character with the latter requiring a more extensive review. A two-level review process is suggested when an application is in conflict with the access standards. A Level 1 Waiver would apply to developments that would not produce an adverse impact on the roadway and where deviation from the standard is insignificant. These could be addressed through basic documentation and streamlined decision-making. A Level 2 Waiver would apply to deviations that have the potential to cause adverse impacts on roadway operations. These would require detailed analysis and consideration by a multidisciplinary variance review committee. In addition, an appeal process should be built into the administrative procedures for access management to assure due process prior to a property owner resorting to a judicial recourse.

Implementation Process

An implementation process involving several steps is also recommended in this report. Central to the process is the creation of an Access Management Implementation Task Force, which would be charged with the responsibility for working out the many details that remain to be dealt with, for marketing and public involvement, and for defining program parameters including procedures and roles/responsibilities. The task force should be diverse and include individuals representing primary stakeholder groups - both within and outside the Cabinet - that have an interest in access management issues.

One of the first tasks to be undertaken by this task force should be the development of a public involvement plan. A public involvement plan should be developed to ensure adequate involvement of stakeholders throughout the implementation process.

Another necessary task is the finalization and formal adoption of access spacing and design standards. The standards and recommendations presented in this report have resulted primarily from an assimilation of practices of other states with access management programs. These recommendations should be examined, revised if appropriate, and formally adopted. In addition, access design standards currently found in the Cabinet's Permits and Highway Design Guidance Manuals should be reviewed for their consistency with the requirements and objectives of the access management program, and appropriate revisions to these manuals should be made.

A third task to be undertaken is the initiation of the classification system. It is expected that this task may take some time to complete, and it is desirable that it be in place when the access management plan becomes effective. Integral to this task is the development of procedures for classification updates and revisions.

Formal implementation of the Kentucky Access Management Program will require legislative action in the form of an Administrative Regulation. The development and processing of the Administrative Regulation will be one of the most critical tasks required of the Access Management Implementation Task Force. An initial decision that will have to be made is whether the existing regulation dealing with highway access (603 KAR 5:120) should be modified or if an entirely new regulation should be developed. The development of procedures for nonconforming access and formal variance and appeal procedures are additional elements to be considered by the task force. Finally, the permitting process for granting access should be evaluated and refined to reflect the proposed standards and regulations.

Implementation of the Kentucky Access Management Program will require an expanded organizational structure, compared to the structure that currently exists for the Cabinet's access permitting function. The Access Management Implementation Task Force will need to determine the location(s) within the Cabinet where access management functions can be carried out most effectively. Implementation of the Kentucky Access Management Program will require new staff skills and new agency procedures. It would therefore be advisable to provide early and ongoing training for Cabinet staff.

Table - 2 Suggested Access Management Spacing Standards for Kentucky

Access Class	Location	Interchange Spacing
Interstates	Urban	1 mile
	Rural	3 miles

Access Class	Typical Functional Class	Interchange Spacing (ft)					Signalized Intersection (ft)	Unsignalized Intersection (ft)	Median Type		Median Opening (ft)		Corner Clearance (ft)[8]
		To Interchange	A[1]	B[2]	C[3]	D[4]			Traversable	Non-traversable	Full	Directional	
Urban I	Principal Arterial	1 mile	900	900	2,400	900	2,400	1,200/600[6]		**X**	2,400	1,200	1,200/600[6]
Urban II	Minor Arterial	NA	600	900	2,400	900	2,400	450	**X**	**X**	2,400	1,200	450
Urban III	Collector	NA	600	600	1,200	600	1,800	300	NA	**X**[7]	1,800	600	300
Urban IV	Local	NA	NA	NA	NA	NA	NA[5]	150	NA	NA	NA	NA	150
Rural I	Principal Arterial	2 miles	1,200	1,200	2,400	1,200	4,800	1,200		**X**	2,400	2,400	1,200
Rural II	Minor Arterial	NA	1,200	1,200	2,400	1,200	2,400	600	**X**	**X**	1,200	1,200	600
Rural III	Collector	NA	NA	NA	NA	NA	2,400	450	NA	**X**[7]	1,200	600	450
Rural IV	Local	NA	NA	NA	NA	NA	NA	150	NA	NA	NA	NA	150

Notes:
1. Distance to first approach on the right from the off ramp gore; right in/ right out only
2. Distance to first left turn from the off ramp gore in divided highways
3. Distance to first major intersection (signal) from the off ramp gore; no four leg intersection between ramp terminals and this intersection
4. Distance to last access connection and start of on ramp taper
5. Not recommended due to typically low volumes; if necessary, 1,200 ft spacing should be used
6. For roadways with speed limit greater than 45 mph use 1,200 ft
7. Recommended for multi-lane facilities
8. Distances shown should be used if greater than turning bay length; a detailed study of the area is recommended prior to driveway approval

1 INTRODUCTION

Over the past decade, a surge of growth across the nation in both the residential and commercial sector has been observed. This growth is particularly important for economic development and prosperity, however, it has been accompanied by what most feel is a less desirable increase in traffic volumes. The traffic generated by such developments often leads to increased congestion and decreased safety. Safety is compromised through the combination of increased traffic and additional access points that may have resulted from the new developments, which in turn creates more conflict points and an increased risk. Additionally, with increased traffic and access points, congestion is amplified. Therefore, it is desirable to find solutions to increased congestion and delays as well to address methods to increase the safety and mobility of vehicular movement on roadways. The concept of access management was developed to address these issues. Access management is a method of controlling roadway access, while serving as an important tool for improving the functionality of roadways. At the same time, it aims at balancing the mobility and accessibility of roadways, while maintaining safety. This concept has been proven effective in reducing crashes, increasing capacity and enhancing economic benefits to surrounding areas (1).

The benefits of access management are achieved through a series of policies that define specific guidelines and standards for allowable access levels, access spacing criteria, access permit procedures, and the means for enforcing these concepts. Access management is defined by the Federal Highway Administration as the process of balancing the competing needs of traffic movement and land access (1). Furthermore, access management

- provides land access without degrading safety or traffic flow,
- utilizes the fundamentals of traffic engineering to determine the appropriate location and design of access,
- evaluates the consequences of new access points, and
- outlines the appropriate guidelines or standards, in addition to addressing the administrative issues.

In a broader context, it is infrastructure protection, since it is a way to anticipate and prevent roadway safety problems and congestion.

The essence of an access management system can be summarized in the following steps:

(1) Classification of roadways based upon functional criteria that reflect the importance of each roadway to statewide, regional and local mobility;

(2) Definition of allowable levels of access for each road class, including criteria for the spacing of signalized and unsignalized access points;

(3) Application of appropriate geometric design criteria and traffic engineering analysis to the allowable access; and

(4) Adoption of appropriate regulations and administrative procedures.

The highest levels of access location and design are applied to freeways and arterials, while access control is less restrictive for lower roadway classes. It is also desirable to establish similar access control for all roads, state and non-state maintained.

Problems with improper access are a result of either an excessive or inadequate number of driveways. The first leads to safety and congestion problems, while the second can lead to a reduction in land value. The latter can also lead to lawsuits due to the limitation of access. To avoid this, the responsible state agency should take steps to prevent or alleviate this problem (2). One of the most important elements in design for reducing crashes is access control. An increase in access points along a roadway leads to an increase in crash risk; therefore, the use of access control can be expected to limit this risk (3). An effective access management program can reduce crashes as much as 50 percent. Access control also reduces travel congestion by increasing capacity and thereby reducing the need for costly lane additions. Reductions in congestion result in shorter travel times and lower air pollution, which contribute to less energy consumption (4). At median crossovers, storage lanes can be introduced to enhance safety. The safety of a roadway will improve if through vehicles are separated from vehicles using access points along the alignment. Additionally, the introduction of turning lanes is beneficial for increasing capacity, since it eliminates the friction between through and turning vehicles (3).

Given these issues a study was initiated that would examine the current practices in Kentucky and propose an access management plan. The first task of this effort was a comprehensive literature review of state practices with respect to access management methods and issues. These findings are presented here. The following sections provide pertinent background information for developing an access management system, including an examination of the practices of other states utilizing access management, the identification of different types of classification schemes, and a discussion of potential techniques that can be used. This report will provide insight into the components necessary for a proper access management plan, as well as the benefits of access management. Additionally, the development of Kentucky's access management plan will be discussed as compared to the current status and practices of access control in the state.

2 BACKGROUND

This section outlines advantages and disadvantages of access management based on past research. The primary components of an access management program are also presented.

2.1 Advantages/Disadvantages of Access Management

Unmanaged access to major transportation facilities often leads to serious negative operational and safety impacts on the use of these facilities. Past research has demonstrated a relationship between crash rates and the number of access points along an arterial (5, 6, 7). These findings indicate that more access points lead to more crashes and often there is more than a direct relationship -- doubling the number of access points per mile typically leads to more than a doubling of crash rates (7, 8). At the same time, a large number of access points also creates operational problems, since through vehicles are likely to be required to slow down behind vehicles that are entering or exiting these access points (9, 10). These findings indicate that the greater the frequency of access points, the larger the speed reduction to the through traffic will be. Therefore, the most obvious impacts of a lack of appropriate access control are reduced capacity of roadway facilities and an increase in traffic crashes. The safety benefits of improved access management are attributable to fewer traffic conflict locations, increased driver response time to potential conflicts, and improved access design. The operational benefits of improved access management are attributable to a reduction in delays at signalized intersections and a reduction in delays caused by vehicles turning into and from the traffic stream. It has been estimated that proper access control can reduce crashes by as much as 50% (6) while capacity can be increased by 23 to 45% (11, 12).

In an effort to promote access management, the Michigan Department of Transportation (MDOT) detailed the benefits of access management with the following five statements (13).

(1) <u>Traffic safety is improved by reducing conflict points.</u> Michigan determined that approximately 68% of traffic crashes are access related. They cited 69 deaths and 13,855 injuries in 33,310 driveway related crashes between 1992-1994 as proof of the problem associated with numerous conflict points.

(2) <u>Travel times and related costs are reduced.</u> The reduction in connections allows for fewer delays, enabling motorists to arrive at their destinations quicker. Additionally,

reduced delays result in lower vehicle operating costs, fuel emissions, and air pollution.

(3) Function and capacity of roadways are increased. The reduction of connections to roadways eliminates turning movements that can slow traffic and degrade the mobility function of the roadway. Good access management preserves the capacity of the road to move vehicles at the posted speed and extends the useful life of the road. By doing so, it also reduces the need to build additional travel lanes that lead to large construction costs.

(4) Access to property increases the value of private land development. Access management that considers proper driveway placement can ensure that driveways be designed uniformly and safely. Businesses with safe and easy access are more inviting to customers.

(5) Improvement in community lifestyle. The practice of access management in communities is likely to result in the following characteristics according to the MDOT:

- Traffic flows smoothly,
- Drivers have ample time to react to turning movements,
- Wide driveway separation results in less sudden stops,
- There is more green space between driveways,
- Signs are spaced more widely and clearly demarcate driveway openings,
- The overall appearance is more attractive.

Balancing transportation needs and land development is a fundamental concept of access management in order to sustain economic growth and maintain a safe and efficient operation of the surrounding road system. To achieve this goal, access management utilizes a series of policies that identify guidelines and standards for allowable access levels, access spacing criteria, access permit procedures, and means for enforcing these standards. Improperly located driveways and intersections, excessive traffic signals, insufficient storage areas for traffic and lack of turning lanes or tapers contribute not only to crashes and congestion but they also reduce the capacity of the roadway system and degrade the character of the area. Effective access management translates into fewer conflict points, reduced traffic delays, higher travel speeds, and improved roadway capacity.

There are also economic impacts that should be considered as part of an unmanaged access system. These impacts may include a reduced desire to travel to congested areas or reluctance to develop an area without proper access structure. This is exemplified by the growing number of older commercial strips across the country that are now experiencing economic decline. On the other hand, improved safety and traffic operating conditions translate into significant reductions in travel time, which may allow businesses to attract customers from a greater distance and have a positive impact on the economy of the area. In addition to the impacts access management may have on businesses production, it has been shown that access control can increase property values. It is widely accepted that the development potential of land is closely tied to the efficiency of the transportation system that serves it. In a Texas study, an 18 percent increase in property values was shown along corridors where access control was implemented (14). Additionally, from the government perspective, the lack of a comprehensive access management program often leads to a continuous cycle of investment in roadway improvements that typically follow development and attempt to address the traffic problems after the fact. Such an approach leads to inappropriate spending of highway funds. Thus, it can be argued that effective access management has the potential to conserve government highway funding.

In spite of the many benefits of properly managed access, regulating driveway access on an existing roadway is often controversial. Owners of abutting businesses often feel that their business will be adversely impacted. Experiences in other states and a limited amount of research suggest that this is not the case. The results of a statewide study of the effects of access management on business vitality in Iowa in 1996 concluded that corridors with completed access management projects performed better in terms of retail sales than corridors with unmanaged access and that business failure rates along access managed corridors were at or below the statewide average for Iowa (15). Other studies of the economic effects of access management on businesses have focused largely on medians and the potential impacts of left-turn restrictions on business activity. The results of these studies indicate that median projects generally have little overall adverse impact on business activity and that changes in access or traffic patterns do not cause a change in the highest and best use of abutting properties. Business owner perceptions of potential impacts of access changes tend to be much worse than actual impacts (14). These studies have also concluded that destination-type businesses, such as offices, specialty stores, and certain restaurants, appear to be less sensitive to access changes than businesses that rely primarily on pass-by traffic, such as drive-in restaurants, gasoline stations, and convenience stores.

2.2 Access Management Components

A good access management program is built upon an appropriate classification of roadways. This classification provides a basis for describing the characteristics and guidelines to be applied to particular roadways. A set of techniques used to impose access management should also be defined as part of the access management program. These techniques include the following:

- Traffic signal spacing
- Unsignalized access spacing
- Corner clearance
- Median alternatives
- Left turn lanes
- U-turns
- Access separation at interchanges
- Frontage roads

Additionally, administrative procedures such as the permit process, the allowance of variations/exceptions, and the appeal process should also be well defined. These procedures work to ensure a fair and consistent application of the techniques listed above.

The following conclusions and observations, as outlined by NHCRP 420, include a number of the impacts associated with the access management techniques listed above (12).

(1) The spacing of traffic signals, in terms of their frequency and uniformity, governs the performance of urban and suburban highways. It is one of the most important access management techniques. Studies have shown that crash rates rise as traffic signal density increases. Each traffic signal per mile added to a roadway reduces speed by about 2 to 3 mph.

(2) Each unsignalized access point introduces conflicts and friction in the traffic stream. The number of crashes at driveways is disproportionately higher than at other intersections. Studies have shown that crash rates rise with greater frequency of

driveways and intersections. In general, each additional access point per mile increases the crash rate by about 4 percent. Speeds are estimated to be reduced by 0.25 mph for every access point.

(3) Corner clearances represent the minimum distances that should be required between intersections and driveways along arterial and collector streets. Driveways should not be located within the functional boundary of intersections. Placing driveways too close to intersections correlates with operational problems and higher crash frequencies

(4) The basic choices for designing a roadway median are whether to install a continuous two-way left-turn lane (TWLTL) or a nontraversable median on an undivided roadway, or to replace a TWLTL with a nontraversable median. These treatments improve traffic safety and reduce delays by removing left-turning vehicles from through travel lanes. Studies have shown that highway facilities with TWLTLs had crash rates that were approximately 38 percent less than those experienced on undivided facilities. The use of nontraversable medians produces additional crash reduction benefits compared to TWLTLs.

(5) The treatment of left turns is a major access management concern. Left turns at driveways and street intersections may be accommodated, prohibited, diverted, or separated depending on specific circumstances. A synthesis of safety experience indicates that the removal of left turns from through traffic lanes reduces crash rates by roughly 50 percent. The provision of left-turn lanes at signalized intersections can significantly increase capacity.

(6) U-turns reduce conflicts and improve safety. They make it possible to prohibit left-turns from driveway connections onto multi-lane highways and to eliminate traffic signals in some situations or simplify signal phasing. U-turns result in a 20 percent crash rate reduction by eliminating direct left-turns from driveways and a 35 percent reduction when the U-turns are signalized. Roadways designed with U-turn crossovers have roughly one-half of the crash rates of roads with TWLTLs. U-turns, coupled with two-phase traffic signal control, result in roughly a 15 to 20 percent gain in capacity over conventional intersections with left-turn lanes and multi-phase traffic signal control. A right turn from a driveway followed by a U-turn can result in less

travel time along heavily traveled roads than a direct left-turn exit when the additional travel is 0.5 miles or less.

(7) Freeway interchanges have become focal points of activity and have stimulated much roadside development in their environs. Although access is controlled within the freeway interchange area, there is often inadequate access control along the interchanging arterial roadway. Where intersections are too close to the ramp termini of the arterial/freeway interchange, heavy weaving volumes, complex traffic signal operations, frequent crashes, and recurrent congestion have resulted. As a result, land development at interchanges should be sufficiently separated from ramp terminals.

(8) Frontage roads reduce the frequency and severity of conflicts along the main travel lanes and permit direct access to abutting property. Frontage roads segregate through and local land-service traffic, thereby protecting the through travel lanes from encroachment, conflicts, and delays. When properly designed, the resulting spacing between the intersections along the main roadway facilitates the design of auxiliary lanes for deceleration and acceleration.

3 PRACTICES

This section presents a review of state practices regarding access management. First, practices of states bordering Kentucky are examined followed by a review of other states that have implemented an access management program.

3.1 States Bordering Kentucky

The seven states bordering Kentucky are Illinois (16), Indiana (17), Missouri (18), Ohio (19), Tennessee (20), Virginia (21, 22), and West Virginia (23). These states have varying methods of dealing with access management, ranging from a complete set of guidelines to guidelines pertaining only to driveways. Missouri and Ohio have a comprehensive access management plan, while Illinois, Indiana, Tennessee, Virginia, and West Virginia have manuals and programs that regulate driveway permits. Detailed descriptions of each of these states can be found in Appendix A.1.

3.2 Other States

All states have some degree of access control, but traditionally these programs have focused on specifics of driveway design and location. Fourteen states, which include Colorado (24), Florida (25), Iowa (26), Kansas (27), Maine (28), Minnesota (29), Missouri (18), Montana (30), New Jersey (31, 32), Ohio (19), Oregon (33, 34), South Dakota (35), Washington (36), and Wisconsin (37) have been identified as having the components of a comprehensive access management program. Additionally, Texas (38) has completed extensive research on access management and proposed an implementation plan. Similarly, North Carolina, which currently has only driveway regulations, is in the process of developing a more complete access management plan. Several other states are likely to change their policies to a more comprehensive approach in the near future. The adoption of a state policy establishes a framework for local action aimed at achieving consistency and coordination both at the state and local level. Appendix A.2 outlines the states with comprehensive access management programs. It should be noted that Missouri and Ohio, which have a comprehensive plan, are discussed Appendix A.1 with the other states bordering Kentucky.

3.3 Key Findings

Table 3-1 presents a summary of the access management practices for the states reviewed. Based on their programs the following key elements and common approaches were noted.

(1) Central to several access management systems is a classification of roadways. Most states have a modified functional classification approach and several have created a new system. The departure from the traditional functional classification system seems to be a more appropriate approach, since it allows for the use of other indicators such as speed, volume, and median type to classify roadways.

(2) The development of standards or guidelines for access spacing for different classes of roadways is also essential to a successful access management plan. These guidelines are often based on stopping sight distance and corner clearance.

(3) There is not a uniform approach regarding local roads. There are several states that encourage adoption of the access management regulations by local agencies, while others do not mention policies for local roads.

(4) There is a trend toward departing from simple permit granting to a more complete access management approach in several states. It has been recognized that most permitting programs allow for inconsistencies and generate significant issues, which could be avoided with the use of an access management system.

(5) The authoritative capabilities of the states vary. Some states have access management plans that have been adopted into statutes, while others are enforced through administrative rules or indirectly utilizing an existing rule-making authority.

Table 3-1 Access Management Practices for States

States	Classification System	Management Techniques Utilised	Access Management/Permit System	Authority	Control	Responsible	Unique Standards/Guidelines	Concerns/Problems	Best Features
CO	Organized by level of roadway importance. Contains 6 primary categoires some of which are subdivided into rural and urban. The six categories are divided by roadway type (interstate, expressway..). Each category and subcategory, when applicable, is given a unique letter designation.	Establishes criteria for access and traffic signals. The width of access and the use of acceleration lanes is also outlined.	Statewide approximately 850 permits per year, permit processing and issuing are handled at the regional level. Recommended as a process that may provide guidance*.	Does not have specific legislation for access management, but power is based under the DOT's rule making authority statute.	Controll 9200 miles of roadway (freeways, expressways, regional highways, arterials.)	Centralized Organization, with permit officers at the regional level	Can apply for a design waiver	Some common information seems to be imbedded in other techniques	Standards are imbedded in code
FL	Medians play important role in the classification. Classified into seven classes designated as class 1-7	Each access class is defined by the type of the median. Each class has standards for connection spacing, median opening spacing and signal spacing. Interchange spacing is based on the spacing standards and the area where it falls.	Applications for access to highways are handled by the Access Management Engineers in the district offices. Recommended as a process that may provide guidance*.	Governed by statute and administrative rules. Statute directs FDOT to create and administer an access management program. Rules containt the administrative process, permit procedures, and other applicable processes.	Controls 11,803 miles of state highways	Decentralized-Each of the seven districts have control, and all districts have Access Management Engineers, that are P.E.'s. The central office has no direct control over access management or design in the districts	Medians are stressed as one of the most important aspects	Classification is not based on function, therefore one road can be different categories	District Access managers are PE's with experience in access management.
IA	Classification is based on highway importance.Classified into 6 priority highways.	Spacing, sight distance and median crossovers for highways are defined.	The manual contains the procedures for acquiring and filling out an entrance permit in addition to the maintenance and policies regarding primary road extensions.	A special access connection shall be recorded by the department in the county recorder's office.			Spacing for special access connections shall conform to rules and shall be maintained on both sides of the highway.	The classification system is not defined completely.	
KS	The KDOT classified state highways according to the level of importance. Routes are designated by the letter A-E, where A has the highest level of control, and E the lowest.	Design and geometric guidelines are outlined for approaches. Medians, islands, sight distances are discussed in regards to design and access management.	All the points of access to the state highway system will be the subject of highway permit. It is a legal document that establishes the relationship between the landowner and/or their agent and KDOT.	The KDOT adopted its guidelines as an access management policy, focusing on broader corridor management.	All state highways are classified. KDOT may also use funds to improve local roads within 0.5 miles of a state highway when it will contribute to better access management for the state route.	District Engineer is responsible for review and approval of all low volume driveways.	Have control over subdivisions abutting state highways	No separation made between rural, urban	Can apply higher standards to specific sections of roadway
MN	It includes 7 primary categories and 5 sub categories. Primary categories are based on the functional classification of the roadway and its strategic importance to certain highways. The sub categories are used to address specific facility types and differing land use patterns that surround the primary roadway.	Criteria for intersection spacing, signal spacing and driveway spacing are established. Information pertaining to spacing is not a design standard, but only a guideline.					Use of gap analysis procedure	The use of the strategic categories may lead to confusion in classifying	Exceptions and deviations are outlined thoroughly
MO	Classified into 10 classes based on the present and the future functional role of the roadway.	The specifications include the standards for interchange spcaing, freeway and expressway transition standards, spacing for public road intersections and traffic signals, driveway spacing and minimum sight distance.		The highways and transportation commission shall have authority over all state transportaiton programs and facilities.	Urban sections are atleast 0.5 miles in length. The designations are subject to change over time. Operational responsibility of state highway system which includes 32,396 miles.		Bus, bicycle, pedestrian recognition	Appeals Process, Variations, and administration Not Outlined Specifically	Thorough guidelines, specifically outlined
MT	Two primary classifications,each of which are divided into two sub-categories. Then those are divided into 2 or 4 more divisions. Some typical speeds are given for each category but are not the guidelines.	The access features included in the approach standards and roadway design are unsignalized access spacing, traffic signal spacing, turn-lane warrants, median opening spacing, corner clearance.		The Transportation Comission has the authoriy to regulate highway access through establishing access control resolutions that limt access rights.			Median use is one of the primary basis of classification.	This information relies on a proposed management scheme	Use and explanation of narrow divisions of categories
NJ	Uses functional class roadway types(# of lanes, divided, median) urban/rural, and speed to determine the access level. The classification matrix contains 54 different cells exclusive of freeways (classified as 0). Each roadway is classified with an access leve, cell #, and desireable typical section.	The access management code set standards for driveways and other means of physical access to and from state highways	Access permits are categorized as small or large, larger developments are dealt with by a separate staff that is largely centralized. Recommended as a process that may provide guidance.	The state passed the State Highway Access Management Act giving the DOT power to create a classification scheme, develop appropriate standards, and the ability to use the permitting process. DOT also works in coordination with the Attorney General's Office.	All state highways are classified, controlled.		A separate staff deals with development	Classification and different levels seem confusing	A great deal of attention is given to traffic signal spacing

Table 3-1 Access Management Practices for States (cont'd)

States	Classification System	Management Techniques Utilised	Access Management/Permit System	Authority	Control	Responsible	Unique Standards/Guidelines	Concerns/Problems	Best Features
OH	Classified into 5 categories. Category-1 includes high volume, high speed and low accessibility roads to category - 5 including low volume, low speeds, and high accessibility.	Each access category has a chart with the various design and specification features. The access features included are permitted movements, spacing, traffic control, trafic movement, right turn lanes, left turn lanes, right and left acceleration lanes. They are further described based on weather they have interchanges or intersections and by the type of volume.	The department will review all the permissions regarding the access permit, some in more detail and length depending on the request.				Section devoted to the need of a TIS	Classification categories may be vague, but all roads were inventoried	Well Structured, complete manual
OR	Classification is divided into rural and urban each of which is subdivided as follows: **Rural**-Expressway, Other **Urban**-Expressway, Other, UBA, STA. (STA-Special Transportation Area. UBA-Urban Business Area)	Spacing standards for both private and public approaches on state, regional and distric highways are defined. Spacing standards applicable to freeway interchangeswith multi-lane cross roads are specifined.No recogination of medians.	Access permits are dealt with at the district offices. Recommended as a process that may provide guidance*.	Administrative rules dictate the standards applied to access management.	Controls 6784 centerline miles of non-freeway type highways of which 6152 miles are rural and 636 miles are urban/suburban.	Decentralized-Each of the 5 districts are responsible for apporval of access permits. Central office provides training, coordination, and reords regarding access control lines on all state highways.	Classification based on unique descriptions	No recognition of medians in respect to spacing standards	They attempt to designate highly populated, urban areas.
SD	Classified into seven categories.	Techniques include signal spacing, median opening, unsignalized access spacing, corner clearance requirements, TWLTL, auxillary lanes, installing barriers to prevent uncontrolled access, install driveway channelizing islands.	Each new access onto the state highway system will require an approved access permit and is granted based on the criteria in the access management rules. Permits for the design projects will be updated in the access database.	Access to South Dakota highways is governed by the administrative rule in the state code.			Analysis of right-in, right-out intersections	Some techniques are somewhat general in terms of application	Guidelines are concise and easy to use
TX	Classified as AC 1 - AC 7 where AC 1 is a multilane, non traversable median roadways and AC 7 is a lower class two-lane roadways.Classification system was designed to reflect roadway purpose, land use, design features, location and safety.	The following techniques were included in the access management program : access spacing and corner clearance for signalised and unsignalised intersection, directional median spacing, full medain spacing criteria, auxiallary lanes, access separation at interchanges, arterial and freeway frontage roads.		To establish and implement a statewide access management program TxDOT requires review of state agencies authority depending upon th statues governing the agency.			Classification base on median and desired accessibility	Classification definitions seem somewhat vague	Medians more thoroughly described than any other guidelines
WA	Four classes.	Frontage roads and interchanges					Pedestrian/H8 Bicycle information	The information is design policy, with only general statements, no specific spacing	Thorough detail about interchanges.
WI	Classifies highways into three categories: Tier I, Tier II, and Other. The system is based on the importance of the roadway. Tier I are the federal and interstate roads, Tier II are the supplemental highways, and the segments without access are classified as others.		WisDOT has permit authority to manage access, deny permit if driveway location is unsafe, and may deny permit if other access is available.	WisDOT is authorized by legisation to control 41% of the total state highway system. In addition WisDOT has official mapping powers, permit authority, ability to declare controlled access, purchase access rights, work with local governements to manage access through zoning.	WisDOT is authorized by legisation to control 41% of the total state highway system, that accounts for 61% of the total vehicle miles of travel. The other category is not controlled. They also have the power to "off-system" improvements if they benefit "on-system" roadways.		Wisconsin can make off-system improvements to benefit state highways	Access guidelines seem to be spread among statutes	

4 ROADWAY CLASSIFICATION

The review of the state practices indicated that roadway classification is the foundation for a successful access management program. It is used to assign access management standards or guidelines that vary by roadway function. Based on the review conducted several different access management classification schemes have been used.

In developing an access classification system, the following factors should be considered (1):

- The nature of the service the roadway is intended to provide.
- The long-term function that the roadway is planned to serve.
- The environment in which the roadway segment is located.
- The desired or appropriate balance between safety and direct access.

Along with these concepts, other roadway characteristics such as traffic volume, median type, speed, and system accessibility should be closely examined. These characteristics are commonly used to divide and subdivide roadways for access management classification purposes. After classification categories are specified, roadway segments are assigned to one of the categories. The classification of the roadway should reflect the long-term mobility objectives, so that reclassification or refinements are not necessary.

The following sections outline different types of classification systems used in states that currently have access management programs. Specific details of each of the states are discussed in Appendix B. For comparison purposes, a number of the states reviewed were divided into three types of classification schemes. While the states within each group have different classification schemes, they share a number of commonalities. The three groups are: general description, functional class, and others.

4.1 General Description

Each of the states discussed in this group use some type of general description to define their particular classes. For example, qualitative statements such as high volume or low speed are used to differentiate between classes, rather than a particular volume or speed. Colorado and Ohio utilize general descriptions and are detailed in Appendix B.1.

4.2 Functional Class Classification

There are a number of states that use some modification of the functional class system, while Minnesota, Missouri, and Washington use the traditional functional classification system as the primary means of categorizing roadways. Appendix B.2 outlines the specific details of the classification system for these three states.

4.3 Other Classification Systems

There are a wide variety of classification systems in use; therefore, they cannot all be grouped in a particular category. Other classification system refers to classification systems that use methods other than functional class and general descriptions. Common factors used for separation of classes include median type and land use. Florida, Iowa, Kansas, Montana, New Jersey, Oregon, South Dakota, and Texas all fall into this broad category and their classification systems are outlined in Appendix B.3.

4.4 No Class System

As discussed in the previous chapter, a number of the states bordering Kentucky utilize driveway permitting guidelines rather than an access management system. Therefore, those states (Illinois, Indiana, Tennessee, Virginia, and West Virginia) do not have a roadway classification system. They often times, however, utilize different approach classifications based on the number of trips generated or on the function of the facility (commercial, industrial, residential, etc.).

4.5 Key Findings

The review of the classification systems used by these states indicates that there are some common themes.

(1) Function of the road is considered in establishment of categories. Sometimes the functional class is utilized unchanged (Missouri), while other times it is used as a supporting point in determining the new classes.

(2) Speeds and volumes are the most common measures used for establishing additional criteria for determining roadway classification. Most states use a qualitative ranking of high, moderate, low, while others use actual speed limits for the distinction.

(3) The type of median has also been used as a factor in determining roadway classification in some states.

(4) The distinction between urban and rural is in line with the United States Bureau of Census for many states. Future urbanized areas are considered sometimes to protect the roadway classification from frequent changes.

5 ACCESS MANAGEMENT TECHNIQUES

In order to enforce access management a number of management techniques are used to regulate spacing and control. These techniques include signal spacing, spacing of unsignalized intersections, corner clearances, traversable and non-traversable medians, turning lanes, U−turns, frontage and backage roads, provision for alternative access, and administrative regulations. Each of the techniques is described in greater detail in the following section. In addition to the research findings, methods of calculating the impact of these techniques are discussed in the final section.

5.1 Techniques

The following Table 5-1 describes commonly utilized access management techniques. Additional information can be found in Appendix C for each technique.

Table 5-1 Access Management Techniques

Techniques	Description
Signalized Spacing	This spacing identifies the minimum desirable distance between signalized intersections. The gap between each signal combined with the number of signals on a given stretch has a significant effect on the operational performance of highways. Signals can account for a great deal of delay and increasing the number of signals along the road often can lead to more congestion. Studies completed on the effect of signal density showed the relationship between delays and safety (39, 40, 41). The conclusions of these studies indicate that long and uniform signal spacing are desirable in order to achieve efficient traffic signal progression at desired travel speeds.
Unsignalized Access Spacing	This spacing examines the desirable distances between non-signalized intersections. Access points are the places of conflict causing friction to the traffic stream. By increasing the space between access points, the number of conflict points can be reduced, thus increasing safety. Research has shown that the greater the access control, the lower the crash rates. Similarly, the greater the frequency of driveways and streets, the higher the number of crashes (42, 43). A key focal area of access management is driveway spacing. The deleterious effect of driveway traffic on arterial operations and on safety is well established by a number of studies including those completed in Denver, Oregon, and Florida (12, 44, 45, 46). Good access management can be attained by proper placement of access points along with proper design of the access points. The addition of an acceleration lane to driveways along an arterial roadway is beneficial to the driveway traffic. Allowing room for driveway traffic to speed up will eliminate the danger of extremely slow moving vehicles entering the traffic flow (47).
Interchange Spacing	Interchanges are the connections for the traffic between freeways and arterial streets. These are points of activity in urban locations and also are the reason for a great deal of roadside development. If an intersection is too close to the arterial/freeway interchange, then it may cause heavy volumes, higher crash rates, and more congestion. Land development at interchanges should be sufficiently separated from ramp terminals in order to avoid heavy weaving volumes, complex traffic signal operations, frequent crashes, and recurrent congestion (44, 48). The spacing should be such that it allows proper merging, diverging, and weaving of ramp and arterial traffic.
Corner Clearance	The corner clearance represents the distance between an intersection and the next access point along the roadway, either upstream or downstream of the intersection. Use of adequate corner clearances removes driveways from the functional area of at-grade intersections. The lack of appropriate corner clearances can result in traffic-operation, safety, and capacity problems (49, 50).
Traversable Median	Traversable medians are medians without physical control over left turns and are typically either flush separation between the directions of travel or two-way left-turn lanes (TWLTL). For highway capacity purposes roadways with TWLTL's are considered as divided highways and there is no need for free flow speed adjustment (51). TWLTLs also improve safety, reducing crashes by up to 34% when placed on a 4-lane undivided highway (52). The center lane also provides operational flexibility for emergency vehicles and reduces left turns from the through lanes. However, the safety gains from TWLTL are lower than when a non-traversable median is present. Moreover, TWLTL do not discourage strip development which is often accompanied by frequent access points (43).
Non-Traversable Median	Medians are widely used for managing access along highways. Divided highways typically experience lower crash rates than undivided highways because they allow fewer opportunities for conflicts and erratic movements. They also provide a pedestrian refuge and have the potential to reduce pedestrian crashes. With the presence of medians it is often necessary to provide median openings periodically to allow for left turn or U-turn movements. Roadways with non-traversable medians showed significantly lower crash rates (30-45%) than roads with TWLTL (12, 40).

Left Turn Lanes	The main problems posed by left turns are increased conflicts, increased delays, and the complication of traffic signal timing (53, 54). The potential for this problem is greater at major highway intersections. This problem is illustrated by the fact that more than two-thirds of all driveway related crashes involve left turning vehicles (55). Left turn lanes are normally provided by offsetting the centerline or by recessing the physical median. The addition of left turn lanes has been shown to be very cost effective. The removal of left turns from the through traffic lanes resulted in crash rate reductions ranging from 18 to 77 percent (56). A Michigan study cited capacity gains of 20 to 50 percent as a result of a permitted two-phase signal operation. This two-phase signal decreases the stopped time for vehicles, thus decreasing the delay (57). Guidelines have been recognized when considering whether a left-turn lane is needed for signalized intersections in Kentucky (58). Additional guidelines for when left-turn lanes should be provided are set forth in several documents for both signalized and un-signalized intersections (54, 59).
U-Turns	To reduce conflicts and improve safety, U-turns are being used as an alternative to direct left turns. U-turn alternatives create about 50 percent fewer conflicts than direct left turns. Additionally, conflicts associated with direct left turns have the potential to be more severe (60). Reducing the number of conflicts decreases the crash risk for drivers (47). The U-turn makes it possible to prohibit left turns from driveway connections onto multilane highways and to eliminate traffic signals that would not fit into time-space patterns along arterial roads. There is an increase in capacity and a reduction in delay when U-turns were provided as an alternative to direct left turns (47, 61). The safety effects of U-turns have been examined through a number of different studies, which have shown a significant reduction in crashes (62, 63).
Roundabouts	Roundabouts are considered an alternative solution for intersection design that could reduce the number of conflict points. Roundabouts have been used extensively in several countries and several have been introduced recently in the US. Roundabouts reduce the number of conflicts at a typical four-leg intersection by 75 percent: from 32 potential conflict points at an unsignalized intersection to 8 points. Roundabouts are considered a very safe form of intersection design and recent studies have documented the savings from their installation (64, 65). These facilities can also improve intersection capacity over signalization; those with single lane approaches seem to perform very well with volumes of up to 2,500 vehicles per hour due to their simplicity (65, 66).
Frontage & Backage Roads	Frontage roads reduce the number of connections to main lines thus reducing the frequency and severity of conflict points along the main travel lanes. Direct property access is provided through the frontage road. The use of frontage roads along arterials that connect with freeways can reduce left turns and weaving, avoid double loading of arterial roads, and improve property access. Commercial development along frontage roads may potentially create congestion and increase the potential for crashes due to the overlapping of maneuver areas, close conflict points, and the complex movements needed to enter and leave the main travel lanes. Therefore, great care must be taken in the design of arterial frontage roads to protect both the arterial and crossroad operations (12). Backage or service roads provide access and connectivity to properties while providing greater separation between the major roadway and the circulation road. Such roads are typically preferred over frontage roads because they provide a better grid system and allow for development on both sides of the road.
Alternative Access	This approach encourages the use and identification of alternative ways that a property can be accessed (43). Such alternative concepts include joint and cross access and internal access to outparcels. Joint access has the potential of reducing the number of direct access points and removes short local trips from the major road to the interior of the development. Access to outparcels is probably one of the largest problems with developments, since each one desires a separate entry. Consolidation of driveways and circulation within the development are desirable to reduce potential conflicts and number of access points.
Administrative	There are few administrative techniques that could be used to enhance and control access management (43). Acquisition of access rights has been used to limit and control access of properties along a roadway. This approach is typically used when safety or operational concerns exist. Land and subdivision regulations are another type of such controls and are used to ensure proper access and street layout of subdivisions. The need for such regulations is essential in ensuring proper connectivity of the subdivision to the major thoroughfares as well as reducing the number of direct access points. The need for interagency coordination is imperative, since often subdivisions are registered with local governments and not necessarily with state agencies. Access management overlay districts have been also used to ensure and preserve access control for designated corridors.

5.2 Impact Calculator

The Impact of Access Management Techniques (IAMT) Calculator (67) provides a set of tools to calculate the effects of changing access conditions along a section of highway by using the applications developed in NCHRP Report 420 (12). The model has the capability to quantify the impacts of spacing for signals, unsignalized access, and interchanges, as well as economic impacts.

5.3 Key Findings

The access management techniques reviewed indicates that there are a variety of methods that could be used to control access and promote efficient traffic flow. However, there are two basic techniques that are central to a successful access management plan. These are intersection spacings, whether signalized or unsignalized, and left turn treatments. The frequent interruptions of flow by any type of intersection can be detrimental both to safety and operation of the roadway. Optimum spacing of signalized and unsignalized intersections provides minimal disturbances of flow and a reduced number of conflict points. Proper spacing between signals and unsignalized intersections in the form of corner clearances also aids in reducing conflicts and improving flow. Another essential component is the handling of left turns to and from the access points, either as direct turns or U-turns. Integral to this choice is the presence and type of median because of the impact that medians have on these turns. Non-traversable medians are the most effective treatment for eliminating conflict points. These two elements are fundamental to a successful access management system and guidelines for each are required to be established for each access class.

6 CONCLUSIONS FROM THE LITERATURE

The basic methods of access management are discussed in this literature review. Additionally, the key components of access management plans were outlined. Central for most access management systems is the classification of roadways. From the review of the states it can be seen that there are a number of different methods of classification used, although most rely to some extent on functional classification. The departure from a strict functional classification system seems to be the preferred approach, since it allows for the use of other indicators to classify roadways for access management purposes**.** Speeds and volumes are the most common measures used for establishing additional criteria for determining roadway classification. Some states use a qualitative ranking of high, moderate, low, while others use actual speed limits for the distinction. The type of median has also been used as a factor in determining roadway classification in some states.

The development of standards for access spacing for the different classifications is also essential to a successful access management plan. These guidelines are often based on stopping sight distance and corner clearance. Review of state practices indicated that there are a number of common links associated with access management. Among these are the techniques used to impose access management. While the states share a number of commonalities in regard to techniques, there is diversity in the administration authority and jurisdiction level.

In general, an emerging trend is being seen for departing from the practice of case-by-case access permitting to a more complete access management plan. It has been recognized that the permit approach allows for inconsistencies and generates significant issues, which could be avoided with the use of an access management system. The lack of a comprehensive approach to access management often leads communities to a continuous investment in roadway improvements that typically follow development and attempt to address the traffic problems after the fact. Effective access management translates into fewer conflict points, reduced traffic delays, higher travel speeds, and improved roadway capacity.

7 CURRENT STATE-OF-PRACTICE IN KENTUCKY

In order to discuss the current state-of-the-practice with respect to access management or control in Kentucky it is necessary to discuss practices at the state and local levels of government separately. Currently, significant differences exist between the access management practices at the state level compared to the local level, and significant differences exist between the programs in place at the local level throughout Kentucky.

Legal authority for access management in Kentucky is inherent in the police power of state and local governments and governmental authority over issues related to public health, safety, and the general welfare. More specifically, the Kentucky Revised Statutes (KRS) Chapter 177 provides the Kentucky Transportation Cabinet with the authority to define, design, construct, and maintain highways whereby the access is controlled. Likewise, KRS Chapter 100 provides local governments with the ability to manage highway access through planning and zoning authority and subdivision regulations. The extent to which the authority to manage highway access is currently exercised at the state level is limited primarily to the Transportation Cabinet's case-by-case access permit review process for state-maintained routes. In addition, access management principles are generally incorporated into the design of highway improvement projects. The extent to which this authority is currently exercised at the local level ranges from nonexistent controls on locally maintained highways and streets to comprehensive programs involving access classification systems and associated spacing and design criteria. State and local programs are discussed in more detail in the sections that follow.

7.1 Access Management Practice at the State Level in Kentucky

7.1.1 Legal Background

KRS 176.050(i) authorizes the Department of Highways to prescribe rules and administrative regulations for the care and maintenance of roads after they have been constructed. KRS 177.106 requires that a permit be issued by the Department of Highways before any encroachment on the right-of-way of a State highway is allowed and gives the Department the authority to order the removal of any encroachment that is found to be interfering with the safe, convenient and continuous use and maintenance of the road. More specifically related to the management of highway access, KRS 177.220 defines a “limited access facility” as “a highway or street especially designed for through traffic, and over, from or to which owners or occupants of abutting land or other persons have no right or easement or only a limited right or easement of access, light, air, or view by reason of the fact that their property abuts upon such limited access facility or for any other reason.” Further, KRS 177.230 gives state and local governments the authority to “plan, designate, establish, regulate, vacate, alter, improve, maintain, and provide” limited access facilities, and KRS 177.240 provides the authority to “so design any limited access facility and to so regulate, restrict, or prohibit access as to best serve the traffic for which such facility is intended.” Also relevant is the declaration in KRS 177.310 that limited access facilities are “necessary for the preservation of the public peace, health, and safety, and for the promotion of the general welfare.” It would appear that these statutes delegate sufficient authority to the Kentucky Transportation Cabinet to implement an access management program (the terms Kentucky Transportation Cabinet and Department of Highways may be used interchangeably in this discussion).

Kentucky Administrative Regulation 603 KAR 5:120, issued under the authority noted above and other statues, defines three types of access control on state-maintained highways, as follows:

"*Fully-controlled access* means all highways which give preference to through traffic and which shall have access only at selected public roads or streets and which shall have no highway at grade crossings or intersections. The termini for control of access shall be as shown on the department's plans” (plans developed at the time of contract letting for highway construction or reconstruction projects together with any subsequent changes made in access control along the route).

"*Partially-controlled access* means all highways which give preference to through traffic. However, access to selected public roads and streets may be provided and there may be some highway at grade intersections and private driveway connections as shown on the department's plans. The termini for control of access shall be as shown on the department's plans.”

"*Access by permit* means all highways designated as access by permit on the department's plans.”

Additional stipulations for partially-controlled access routes are established in KRS 177.315. This statute establishes that the minimum spacing between access points shall be 1,200 feet in rural areas and 600 feet in urban areas but allows a reduction in the spacing of up to 15% if supported by an engineering and traffic study approved by the state highway engineer. The distinction between rural and urban areas for this purpose is defined in 603 KAR 5:120 and is based on the posted speed limit - an urban area is defined by a highway speed limit of 45 mph or less.

Guidelines for access control by permit routes are established in 603 KAR 5:120, which states that additional access points may be allowed based on "established criteria that considers the safety and the interest of the highway user." This established criteria is that which is contained in the Transportation Cabinet's Permits Guidance Manual, which is incorporated into the administrative regulation by reference.

7.1.2 Current Conditions and Practice

There are currently (as of January 2003) 27,443 miles of state maintained roads and streets in Kentucky (total public road mileage is 78,913). Of this mileage, 1,452 miles are fully-controlled access routes. Fully-controlled access routes are primarily Interstates and Parkways, but this mileage also includes approximately 25.5 miles of other routes, most notably KY 841 (Jefferson Freeway) in Jefferson County and a portion of KY 4 (New Circle Road) in Fayette County. The Transportation Cabinet does not maintain a database of partially-controlled access routes, so the total mileage of roadways with this degree of access control is unknown. Roadways that are not designated as fully-controlled or partially-controlled would be classified as access control by permit routes. The vast majority of the state maintained mileage in Kentucky involves access control by permit.

While highway engineers and planners at the state level generally understand the benefits of access management, it is basically correct to say that the Kentucky Transportation Cabinet does not currently have an access management program. Access to the vast majority of state-maintained highways is currently managed on a site specific, case-by-case basis through the Cabinet's access permitting process. And, while decisions made during the permit review process are certainly influenced by principles of sound access management, the fundamental elements of an access management program (hierarchical classification system with associated access spacing and design criteria) are not in place at this time.

Current procedures for access control and access permitting are extensively documented in the Cabinet's Permits Guidance Manual and Design Guidance Manual. Of primary interest in this discussion are specifications and criteria related to the allowance of new access points on the state highway system. Specific access spacing standards are in place for routes designated with partial-control of access, but such standards do not exist for routes with access control by permit.

As noted previously, the minimum spacing between access points on partially-controlled access routes is 1,200 feet in rural areas and 600 feet in urban areas. However, a reduction in the spacing of up to 15% can be allowed if an engineering review does not find that the reduced spacing would create safety or operational problems. With the 15% reduction, the minimum spacing between access points on partially-controlled access routes becomes 1,020 feet in rural areas and 510 feet in urban areas. One problem which has been noted with the current practice for allowing new access points on partially-controlled access routes is the criteria used to establish whether the requested access point is in a rural or an urban area. This distinction is based solely on the posted speed limit on the affected route. A speed limit of 45 mph or less establishes that the urban spacing standard applies. This definition of urban area creates an undesirable situation where landowners and developers desiring more frequent access can petition the Cabinet for a lower speed limit and effectively reduce the minimum access spacing by 50%. Even in the absence of human intervention, this definition creates a situation where a new highway constructed on the fringe of an urban area (a bypass for example), and originally designed with 1,200-ft. access spacing, automatically has its access spacing standard reduced by 50% (or more) when traffic volumes increase to a level that warrants a lowered speed limit. The result is a paradoxical relationship where the mobility function of such a facility becomes degraded just as usage and the need for mobility service increase. This undesirable outcome for a rather naturally occurring situation is indicative of a major flaw in the current system.

For routes with access control by permit requests for new access points are reviewed based on safety considerations, consideration of the "interest of the highway user", and conformance with "established criteria" in the Permits Guidance Manual. For this type of access control, general guidance is provided rather than specific spacing standards. The most specific guidance in the Manual (and even this statement is prefaced with a "generally" condition) is what is known as the Six-second Visibility Rule. This rule states, "Generally, entrances will be permitted where a minimum visibility time of six seconds in both directions is available. The six-second rule is related to whichever is smaller, the 85th percentile or the posted speed limit." This rule has proven to be somewhat difficult to apply in a consistent manner, from District to District, throughout the state. Additional criteria in the Permits Guidance Manual restrict the number of driveways allowed based on property frontage (three driveways may be allowed to a property if the frontage exceeds 300 feet in an urban area or 600 feet in a rural area).

As previously noted, access management principles are generally incorporated into the design of highway improvement projects. New routes are generally designed with partially-controlled access, and in some cases access spacing exceeding the 600/1,200-foot criteria has been negotiated with property owners and local governments. For reconstruction projects, the desire to increase access spacing and control for mobility and safety reasons will often be identified as part of a project's purpose and need. In other instances this desire has surfaced from public comments during the project development process. A strategy that has been employed by the Cabinet for major reconstruction projects on primary state routes, where conditions are feasible, is to convert access by permit routes to partially-controlled access routes. Alternatives developed during the project development process will often include both access by permit and partially-controlled access options, and in an increasing number of cases the selected alternative will involve a corridor access management plan with negotiated access spacing and binding agreements with property owners. Typically, this will involve the use of frontage roads along portions of the route where existing access spacing does not meet design criteria.

7.2 Access Management Practice at the Local Government Level in Kentucky

The manner in which access management is practiced at the local level in Kentucky ranges from nonexistent controls on locally maintained highways and streets to comprehensive programs involving access classification systems and associated spacing and design criteria. As a general assessment, it can be said that the vast majority of local governments do not have formal access management programs in place. However, there is a growing awareness of the benefits of managing highway access in local planning and public works departments, and increasingly, access management principles are being applied in the various review and approval processes required for new development and redevelopment proposals.

The planning and zoning statutes contained in the KRS Chapter 100 have advanced the prominence of local planning in Kentucky significantly. KRS 100 states that before local planning and zoning operations may be conducted, a planning unit must be designated. Planning units may consist of: a city or county acting independently; cities and their county acting jointly; or groups of counties acting regionally. Presently, planning units exist in 95 of Kentucky's 120 counties. Approximately 50 counties have joint city/county planning commissions, but 24 of these do not exercise zoning controls in the unincorporated portion of the county. In approximately 45 counties planning and zoning is conducted by independent planning commissions, which provide controls within one or more incorporated city in those counties. It should also be noted that an independent city planning commission is permitted to exercise extra territorial jurisdiction for the purposes of subdivision regulations and other controls up to five miles beyond the city's boundary and that counties that do not choose to establish a planning unit may still adopt subdivision regulations by fiscal court action.

A basic requirement of a planning commission is the development of a "comprehensive plan". KRS 100.183 requires that, "The planning commission of each unit shall prepare a comprehensive plan, which shall serve as a guide for public and private actions and decisions to assure the development of public and private property in the most appropriate relationships." The comprehensive plan is required to contain the following components: a statement of goals and objectives; a land use element; a transportation plan element; and a community facility plan element. The comprehensive plan may also include additional elements such as community renewal, housing, flood control, pollution, conservation, natural resources, regional impact, historic preservation, or other programs that further serve the purposes of the plan. It is required that the elements of the comprehensive plan be reviewed and amended if necessary by the planning commission at least once every five years.

The vast majority of areas within Kentucky that are under the authority of a planning commission will have both zoning ordinances and subdivision regulations that provide a wide range of controls over development within the covered area. Zoning ordinances and subdivision regulations are developed to be consistent with the comprehensive plan for the area, but these regulations appear to differ significantly in scope and detail from area to area. Elements of access management are often found in either the zoning ordinances or the subdivision regulations, or both. In some cases (Boone, Campbell, and Kenton Counties are examples), comprehensive access management policies, based on a classification system and associated access spacing and design criteria, are incorporated into these regulations. In other cases, certain elements of access management are included, but the approach is something less than comprehensive. And, in still other cases, principles of access management will be advocated within the regulations, but details will be lacking.

Two areas within Kentucky - Owensboro and Bowling Green - are known to have specific access management codes or policies that extend beyond those contained in the subdivision regulations and/or zoning ordinances. These regulations are based on classification systems and associated access spacing and design criteria. The overall results are essentially the same as those obtained by means of the comprehensive access management programs described above, but these separate regulations treat the subject of access management in more depth than would normally be included in zoning/subdivision controls.

7.3 Coordination between KYTC and Local Governments on Access Related Issues

Development plans requiring approval by local planning units and involving access to state highways are routinely forwarded by local agencies to the appropriate Highway District Office. This coordination is necessary in order for the property owner to obtain the required access permit. In addition, KRS 100.287 states, "The state department of highways may file with the planning commission of any planning unit exercising subdivision jurisdiction, a map of the territory within one mile on either or both sides of any existing or proposed highway. After receipt of the map by the planning commission, the commission shall approve no preliminary plats until one copy of such preliminary plat has been referred to the designated office of the department of highways for its review. If the department of highways desires to make any recommendations on the plan, it shall communicate such to the planning commission within 15 days after the receipt of the plat." The Transportation Cabinet rarely provides input in these situations unless direct access onto a state route is involved.

The Cabinet's Permits Guidance Manual (Sections PE-105-4 and PE-304) states that, "Encroachment permits on state-maintained roads, within the corporate limits of a municipality or county, may be issued by that city or county, if they have provided the state a copy of their policy and procedure that is equal to or more stringent than the Department's. These agencies must be notified in writing that they are authorized to issue permits on the behalf of the Department." To date, no city or county has formally assumed this responsibility, although the City of Lexington is in the process of doing so for all routes inside of New Circle Road.

The Guidance Manual also states in Section PE-109-1, "No permit will constitute a license to perform any work that is inconsistent with or that does not meet the requirements of local, state, federal, and/or any other agency having jurisdiction over the permitted work location. The applicant must obtain approval from all agencies having jurisdiction before beginning work." Similarly, Section PE-109-2 states, "A permit does not negate any requirements of any other governmental agencies." This language does not appear to be adequate to insure desired coordination, and it does not sufficiently address situations where local access spacing or design standards may be more stringent than state criteria.

Interviews with staff personnel from local planning and public works departments suggest that the frequency and degree of cooperation and coordination between the Transportation Cabinet and local agencies on highway access related issues varies greatly from District to District within the Cabinet. This variation is due somewhat, certainly, to differences in the levels to which local involvement in access matters has evolved, but it appears to be more a function of the people involved and the working relationships that have been developed. In some areas all, or the vast majority of, state access permitting decisions are made without seeking local input. In other areas there is routine coordination between state and local officials, including relationships where the state will not issue a permit without prior local approval. This inconsistency is undesirable, and it should be relatively easy to eliminate. It is recommended that formal requirements for coordination with local agencies with planning authority be incorporated into the state's permitting procedures.

Problems have been noted by local agencies in situations where local access policies are more stringent than the state's. Local agencies with highly evolved access management programs will typically have access spacing and design standards that are more detailed and specific, more regulatory, and more limiting than state criteria - particularly for routes where the state's level of control is access by permit. In the absence of adequate coordination, the result has been instances where the state has approved an access permit for a location or configuration that has been denied by the local agency. In many cases planning commissions or higher legislative bodies have overturned decisions made by their supporting planning/public works agency staff when a developer argues that the Transportation Cabinet has approved access that has been denied by the agency (or that the Cabinet does not require auxiliary lanes or other impact mitigation measures that have been required by the agency). These situations undermine the effectiveness of local programs and call attention to the need for formalized coordination requirements.

7.4 Summary of Kentucky Practice

Significant differences exist between access management practices in Kentucky at the state level compared to the local level, and significant differences exist between the programs in place at the local level throughout Kentucky. Management of highway access at the state level is limited primarily to the Transportation Cabinet's case-by-case access permit review process for state-maintained routes and to negotiated access spacing improvements that are incorporated in the design of major highway improvement projects. Management of highway access at the local level ranges in scope from nonexistent controls to comprehensive programs involving access classification systems and associated spacing and design criteria.

Administrative regulations issued under Transportation Cabinet's authority to limit highway access define three levels of access control: fully-controlled access, partially-controlled access, and access by permit. For partially controlled access routes the minimum spacing between access points is 1,200 feet in rural areas and 600 feet in urban areas, with an allowable reduction in the spacing of up to 15% if supported by a traffic study. For access by permit routes, additional access points may be allowed based on considerations of safety and the interest of the highway user. The Transportation Cabinet's Permits Guidance Manual provides general guidance rather than specific spacing standards for this level of access control. For many situations the six-second visibility rule is applied.

A problem noted with the current practice for allowing new access points on partially controlled access routes is the criteria used to establish whether the requested access point is in a rural or an urban area. This distinction is based solely on the posted speed limit on the affected route; a speed limit of 45 mph or less establishes that the urban spacing standard applies. This definition of urban area can cause a reduction in access spacing by 50% or more and result in degradation of the mobility function of a route as traffic volumes and the need for mobility service increase. For access by permit routes, the major shortcoming in the current practice is judged to be the difficulty of applying the Cabinet's general criteria in a consistent manner throughout the state.

There is a growing awareness of the benefits of managing highway access in local planning and public works departments, and increasingly, access management principles are being applied in the various review and approval processes required for new development and redevelopment proposals. Elements of access management are often found in zoning ordinances and/or subdivision regulations administered by local planning commissions. In some cities and counties, comprehensive access management policies, based on a classification system and associated access spacing and design criteria, are incorporated into these regulations.

The frequency and degree of coordination between the Transportation Cabinet and local agencies on highway access related issues was found to vary greatly from District to District within the Cabinet. Problems have been noted by local agencies in situations where local access policies are more stringent than the state's. A lack of adequate coordination and formal inter-agency review procedures has, at times, served to undermine the effectiveness of local programs.

8 PROPOSED ACCESS MANAGEMENT CLASSIFICATION

8.1 Introduction

A finding of the literature review and the survey of states indicated that the core element of a comprehensive access management system is a roadway classification system. Such a system allows for the identification of strategies for access management that can be related directly to roadway function.

Most of the systems used by other states have utilized existing functional classification as a basis for their roadway classification system. The rationale for this approach is that allowable access should be correlated with a roadway's purpose and importance. Functional classification is the process by which streets and highways are grouped into classes according to the character of service they are intended to provide. Functional classification system designations have been established and maintained more by all state highway agencies since the early 1970s, based on definitions and criteria established by the Federal Highway Administration. This system recognizes the hierarchy of the road system and the dual role that the highway network plays in providing travel mobility and access to property. A fundamental characteristic of each functional class definition is the relative priority placed on service to major traffic movements versus service to abutting land. Given this obvious affiliation with access management principles, and recognizing that the primary purpose of access management controls is to preserve the functionality of a given roadway, the functional classification system serves as a very logical starting point for the designation of an access management classification system.

The relative stability of the functional classification is another reason for using it as the basis for any classification system. Functional classification is typically reviewed at the same intervals as the census is conducted, i.e. every 10 years. Thus, periodic examination guarantees both infrequent change and the ability to address changes in roadway character that may occur over a longer period of time. It should be noted, though, that exceptions to this rule are cases where new roads are constructed aiming to replace the function of another roadway. Such an example is the construction of a bypass that may assume the classification of the roadway that it replaces, which in turn receives a lower functional classification designation.

Additional indicators that have been used by other states include traffic volume, speed, geometric features (number of lanes and median type), and land use. Traffic volume, speed and geometric features were considered as those indicators that could be used in establishing a roadway classification system for an access management plan in Kentucky. Land use information is fairly rudimentary in the existing Highway Information System (HIS), and thus it is not recommended for use in the initial classification approach.

Several states have used qualitative descriptions for traffic volumes, such as high, medium, and low. However, this approach may create problems regarding the establishment of access management control because it allows for varying definition of these terms. High volumes have been interpreted broadly and easily fall in the range of 10,000 to 20,000 vehicles per day. With such variance, the ability to establish limits where access control should change becomes difficult. Moreover, set values are desirable to provide for establishing a set of rules that could be used in an appeals process to identify qualifying cases and reject inappropriate ones. On the other hand, the use of traffic volume alone would pose a problem since traffic can vary from year to year and thus allow roadways to frequently change class. This would be contrary to the need for a stable class system, and it would defeat the attempt to establish a definitive access management control.

Speed limit has also been used by several states in defining a roadway classification system. Operating speed along a section of roadway affects the speed differential between through vehicles and those turning from or onto the roadway. Also, as speed increases, a driver's perception-reaction time and the distance required to make a maneuver safely will both increase. Therefore, the level of access management necessary to attain a desired level of safety is highly dependent on speed considerations. Some states have used specific speed limits (Florida uses 45 mph) while others have used qualitative measures for defining operating conditions (Ohio and Colorado use high and low speeds). The use of a specific value as an indicator is considered appropriate for speed for the same reasons noted above regarding the traffic volumes. Again, the use of speed alone would pose a problem, since speed limits could be changed easily to allow for altering access control.

Geometric features, such as presence of median and number of lanes, have also been used by some states. The presence of a median could be used as an indicator of the potential for higher access control. However, this geometric feature would likely be utilized only in the higher roadway classes. The number of lanes could be used to differentiate between roadway classes since multi-lane facilities may require higher access control. This indicator could also be useful for the higher roadway classes. Moreover, both median presence and number of lanes could be used to further refine access control strategies within a class, and this is the area where they could be of significance and assistance. The presence of a median could provide an opportunity for increased control of left turning movements. Likewise, the number of lanes may prohibit left turn movements due to potential safety consequences of traversing a large number of lanes to complete left turns.

Given the data presented here, it is recommended to utilize functional classification and a combination of traffic volume and speed limit for developing the proposed roadway classification system for an access management plan in Kentucky. Traffic volume and speed limit combinations will be used to identify roadways where the access control for a given functional class could be increased or decreased. These combinations will provide a means of identifying those roadways where the functional class concepts should be preserved as well as roadways where these concepts need some adjustment. It is envisioned that roadways with low volumes and speed limits could have a lower access management control than roads with higher volumes and speed limits within a single functional class. Similarly, roadways with high volumes and speed limits could have a higher access control than roadways within the same functional class with lower volumes and speed limits. In the next section, a set of these combinations is identified and used to develop a proposed roadway classification for the access management plan in Kentucky.

8.2 Access Management Classes

The first step in the development of the new access management classification system is an understanding of the current roadway network and its mileage for various combinations of speed limits and traffic volumes within each functional class. This analysis allows for the identification of possible breaks in the data and the potential combinations that could be meaningful in determining the limits for each new category. It should be also noted that only the sate-maintained roadways are considered in this effort.

8.2.1 Functional Class

The first analysis was completed to examine the mileage distribution among the existing functional classes. The urban/rural distinction used in the functional classification will be maintained here as well. The roadways examined here are only those maintained by the Kentucky Transportation Cabinet and the total mileage of these roads is 27,476 miles. The HIS data indicate that for urban roadways there are 649 miles of principal arterial (excluding interstates and parkways), 930 miles of minor arterial, 410 miles of collector, and 115 miles of streets with a functional classification of local. For rural roadways there are 1,452 miles of principal arterial, 1,633 miles of minor arterial, 16,364 miles of collector, and 4,473 miles of streets with a functional classification of local. Finally, there are 319 miles of urban and 1,131 miles of rural interstates, parkways, and other fully-controlled access freeways.

8.2.2 Traffic Volumes

A cumulative distribution of the traffic volumes by functional class was developed in order to define possible volume breaks and changes within each class. These distributions indicated the following trends:

- For urban principal arterials, approximately 84% of the mileage carries an ADT equal or greater than 10,000 vehicles per day.
- For urban minor arterials, approximately 74% of the mileage carries an ADT equal or greater than 5,000 vehicles per day.
- For urban collectors, approximately 81% of the mileage carries an ADT less than 5,000 vehicles per day.
- For rural arterials, approximately 74% of the mileage carries an ADT equal or greater than 5,000 vehicles per day.
- For rural minor arterials, approximately 74% of the mileage carries an ADT equal or greater than 2,500 vehicles per day.
- For rural collectors, more than 85% of the mileage carries an ADT less than 2,500 vehicles per day.

8.2.3 Speed Limits

A similar analysis to the traffic volumes was undertaken for speed limits. The data showed the following trends:

- For both urban and rural principal arterials the majority of mileage is for roads with speed limits greater than or equal to 45 mph (urban 62% and rural 91%).
- For urban minor arterials, approximately 62% of the mileage has speed limits less than 45 mph.
- For urban collectors, approximately 63% of the mileage has speed limits less than 45 mph.

The use of 45 mph as the dividing speed limit for access control purposes was considered appropriate based on the distribution of principal arterial mileage for both urban and rural roads. The 45 mph speed is also used as the upper limit of design speed that allows for the use of curb and gutter on urban roadways and thus could provide for different access control. Finally, the Green Book recommends that rural arterials be designed with speeds ranging between 40 to 60 mph.

8.2.4 Proposed Roadway Classification System

A set of four classes for urban and rural roadways is proposed to maintain a reasonable number of classes and some resemblance to the functional classification system. Interstates, parkways and other freeways that have full access control will be treated separately and will belong to two individual categories--one for rural (Rural F) and a second for urban (Urban F). The remaining classes are defined as Rural I, II, III, and IV and Urban I, II, III, and IV. The initial correspondence between functional class and these categories for both urban and rural roadways is as follows:

- I - Principal Arterial
- II - Minor Arterial
- III - Collector (both Major and Minor in rural)
- IV - Local.

Given the data presented previously, the use of 45 mph for both rural and urban categories will be used to indicate roadways that might be shifted to a more or less restrictive access class than that initially established by the functional classification. This speed is considered as the upper design speed for urban design, i.e. cross section with curb and gutter, and it could be used to differentiate between higher and lower access control for urban roadways. The same speed was also selected for rural roadways, since the majority of rural arterials, both principal and minor, had speed limits greater or equal to 45 mph. The volume breaks identified previously will also serve as the defining limits for increasing or decreasing access control within a functional class. Roadways with high volumes and high speeds will be moved up to a more restrictive access class, while roadways with low volumes and low speeds will be moved down to a less restrictive access class. It was also decided that a roadway section should only be allowed to move up or down one class to maintain a reasonable association with its functional class. Finally, local roads will remain within their own category as they are currently classified and no movement will be allowed to a higher category. This is consistent with the functional purpose of local roads and streets, which places a high priority on access. Utilizing these principles, the new roadway classification categories are presented in Figure 8-1. The numerals in the cells represent the new roadway classification and are indicative of the upgrading and downgrading of access control within a functional class.

Principal Arterial						

Rural — Principal Arterial

	Volume	
Speed	<5,000	≥5,000
≥45	I	I
<45	II	I

Urban — Principal Arterial

	Volume	
Speed	<10,000	≥10,000
≥45	I	I
<45	II	I

Minor Arterial

Rural:

	Volume		
Speed	<2,500	≥2,500	≥5,000
≥45	II	II	I
<45	III	II	II

Urban:

	Volume		
Speed	<5,000	≥5,000	≥10,000
≥45	II	II	I
<45	III	II	II

Collector

Rural:

	Volume	
Speed	<2,500	≥2,500
≥45	III	II
<45	III	III

Urban:

	Volume	
Speed	<5,000	≥5,000
≥45	III	II
<45	III	III

Local

Rural:

All speeds & volumes	IV

Urban:

All speeds & volumes	IV

Figure 8-1 Use of Functional Class, Traffic Volumes and Speed Limits for Roadway Classification

Table 8-1 presents a definition of each of the new access management classes and Table 8-2 summarizes the total mileage for each of the new categories and indicates the amount of shifting among the classes.

Table 8-1 Definition of Access Management Classes

Class	Location	
	Urban	**Rural**
F	Freeways, Expressways, Parkways with full access control	Freeways, Expressways, Parkways with full access control
I	Roads with high volumes and high speeds, placing a high priority on mobility, long distance travel through urban areas, typically including principal arterials, multi-lane facilities often with median.	Roads with high volumes and high speeds, placing a high priority on mobility, long distance travel between urban areas, typically including principal arterials, often multi-lane facilities.
II	Roads with moderate volumes and speeds, placing priority on mobility, used for intra-city travel, typically including minor arterials, often multi-lane facilities.	Roads with moderate volumes and speeds, placing priority on mobility, used for inter-city and interregional travel, typically including minor arterials, often two-lane facilities.
III	Roads with low volumes and speeds, balancing access and mobility, short distance travel within urban centers, typically including collectors, often two-lane facilities.	Roads with low volumes and speeds, balancing access and mobility, short distance travel in rural areas, typically including collectors, two-lane facilities.
IV	Roads with very low volumes and speeds, placing a high priority on access, travel for local access, typically including local streets.	Roads with very low volumes, placing a high priority on access, travel for local access, typically including local streets.

Table 8-2 Access Management Roadway Classification Mileage

Functional Class	Access Management Class											
	Urban (miles)					**Total (miles)**	**Rural (miles)**					**Total (miles)**
	F	**I**	**II**	**III**	**IV**		**F**	**I**	**II**	**III**	**IV**	
Freeway/Parkway	319					319	1,131					1,131
Principal Arterial		595	54			649		1,409	43			1,452
Minor Arterial		131	655	145		931		405	1,137	91		1,633
Collector			58	373		411			1,504	14,861		16,365
Local					115	115					4,473	4,473
Total	319	726	747	518	115	2,425	1,131	1,814	2,684	14,952	4,473	25,054

8.2.5 Implementation Process

The proposed access classification could be initially implemented using the available information provided in HIS. Using the variables and limits defined, each roadway section could be assigned to one of the new classes defined here. A minimum section length of 0.5 miles for urban and 1 mile for rural sections is considered appropriate. It is envisioned that the initial class assignments will be plotted using GIS, and they will be forwarded to each District for evaluation and potential adjustment. The GIS mapping will allow for determining areas where frequent changes from one class to another occur, which would disrupt the continuity of the access management along the route. The use of minimum section lengths will eliminate many such changes, but additional adjustments will likely be desirable. The final decision for such changes is more appropriately made at the local level, i.e. by each District. Frequent changes from one class to another should be avoided whenever possible.

As noted previously, the use of the functional class as the basis for this classification system has the advantages of being fairly stable and subject to periodic review. The roadway functional class is examined after each census to determine whether any changes are necessary both in the urban/rural distinction as well as in the actual class of the road. The only other time that a functional class will change within the decade is when new projects assume the functional class of the roadway they replace and thus the old road assumes a lower classification. The combination of functional class, volume, and posted speed creates the environment for infrequent changes. In most cases, the speed limit of a roadway could not simply be adjusted to require a change in access spacing, as is the case now with partial-control of access routes. It should be understood that these three criteria would be used for the initial assignment of access management classes. Subsequent changes to the classification should be considered only in cases where the function of the roadway has been deemed to change. It is recommended that this determination be made by a multidisciplinary review committee to be established for this purpose. The review committee should include members from the Divisions of Planning, Traffic, and Design from the District Office where the request was initiated. This procedure would insure a stable classification system, which is essential to the success of the access management system, while still allowing the potential for change when it is deemed appropriate.

It should be expected that the Cabinet would receive frequent requests to reclassify a particular roadway segment into a lower access management classification. Pressure to do this would likely stem from the perception that development would benefit from the more liberal access permitted by the lower classification. Frequent and/or piecemeal changes in classification are strongly discouraged, as this practice would degrade the effectiveness of the access management system. Also, from the development perspective, it should be understood that, in the long run, the increased access would contribute to increased congestion and decreased safety. These consequences could lower the value of abutting development.

As noted here, each District office will be requested to review and refine the initial classification. Such refinement is desirable to identify cases where the volume and speed data may not have properly classified a roadway segment or when existing conditions necessitate a different classification. In this case additional indicators could be used to justify the change. Such criteria to be used may include adjacent land use or land use plans, presence and type of median, and number of lanes. Some examples of such potential adjustments may include the following:

- Existing intersection spacing and access needs along a principal arterial in a CBD area would likely be inconsistent with Urban I criteria and warrant a lower class assignment.
- Opportunities for more effective access management (than that based on the initially assigned class) along an undeveloped urban route might warrant a higher class assignment.
- A roadway section with a rural functional classification but with urban-like characteristics, such as "Main Street" through a small city (not large enough for urban area designation), might warrant a change from a rural to an urban category.
- A roadway section with an urban functional classification but with rural-like characteristics, such as areas beyond the urban service area in Fayette County, might warrant a change from an urban to a rural category.
- A route through an urban/suburban area that is planned for substantial development or redevelopment might warrant a higher class assignment in order to encourage smart growth.

- Presence of a non-traversable median would indicate possibility for applying a higher Access Management Class.
- A multi-lane facility or a much higher than normal traffic volume would indicate candidates for a higher Access Management Class.
- Roads scheduled for major reconstruction or widening could warrant a higher class assignment in order to preserve the mobility benefits of the improvement investment.
- Routes that have a higher function from a local perspective than that assigned at the state level or that have a local strategic importance (such as routes that provide access to a hospital, school, or other major traffic generator or routes that serve as a gateway to a city) could warrant a higher class assignment.

9 ACCESS SPACING

9.1 Introduction

Spacing guidelines and/or standards are an integral component of access management. These spacings are directly related to the classes established in the classification systems. The guidelines are the mechanism used to "preserve the functional integrity of highways, provide for smooth and safe flow, and afford abutting property an appropriate degree of access (54)."

NCHRP 348 outlined the following considerations in regard to access spacing (54):

(1) Allowable access should vary by access class, facility type, roadway speed, and development density.

(2) Access spacing guidelines do not have to be consistent with existing access practices.

(3) Guidelines should apply to new developments (where none exist) and to significant changes in the size or type of existing developments.

(4) Allowable tolerances for deviations from the desired standards generally should vary with the access level or functional class of highway involved. These tolerances can be greater for collectors and minor arterials than they are for principal arterials.

(5) Traffic signal spacing for both driveways and at-grade public intersections should be related to speed (i.e., posted speed limit).

(6) Signal spacing criteria should govern both intersecting public streets and access drives. They should take precedence over the unsignalized spacing standards in situations where there is the potential for future signalization.

(7) Locations for signalized at-grade intersections ideally should be identified first. Unsignalized right- and left-turn access points should be selected based on existing and desirable future signal locations. Grade separations may be needed in some circumstances where major roadways intersect or as a means of providing direct access between arterials and large traffic generators.

(8) Reasonable alternative access must be considered. However, care should be exercised to avoid merely transferring problems.

(9) Access for land parcels that do not conform to the spacing criteria may be necessary when no alternative reasonable access is available. The basis for these exceptions or variances should be identified.

9.2 Sight Distance Issues

A fundamental aspect of roadway design is the provision of adequate sight distance along the roadway to allow the driver to properly react to various conditions. The provision of adequate sight distance that would allow drivers to safely complete their intended maneuvers is a very important and controlling aspect of all access spacing. Sight distance obstructions will create an unsafe environment and will have the potential to increase crashes. In general, sight distance at intersections involves the examination of sight triangles between approaching and departing vehicles as shown in Figure 9-1.

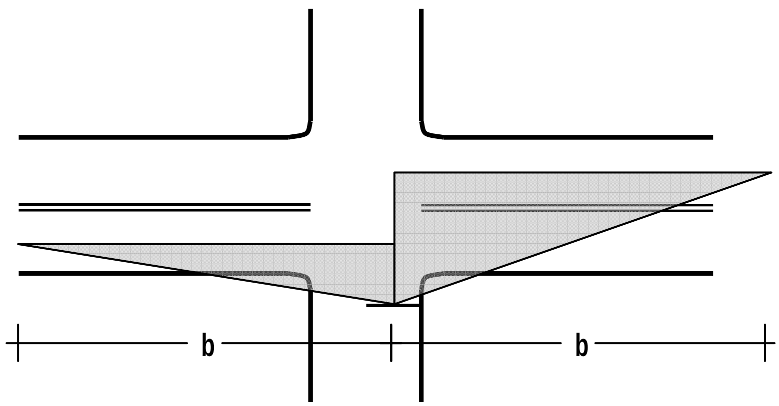

Figure 9-1 Intersection Sight Distance Triangles

Most of the states reviewed use the guidelines provided by AASHTO in the *Policy on Geometric Design for Highways and Streets* (68). These states include Iowa (26), Michigan (13), Minnesota (29), Missouri (18), Virginia (21), and West Virginia (23). There are a few states that use the previous edition of the AASHTO guidelines, which are based on lower object height, including Indiana (17), Kansas (27), and Oregon (33). Regardless of the approach taken, this review indicates that most states indeed address this issue and consider sight distance as an integral part of their access management guidelines.

In Kentucky, these distances have traditionally been considered based on the “6-second” rule, which defines the distance (*b* in Figure 9-1) traveled in 6 seconds at the posted speed limit. This time is the time gap that drivers find acceptable to enter from the side road and complete their intended maneuver. The current edition of the *Policy on Geometric Design for Highways and Streets* (68) requires larger time gaps for establishing intersection sight distance. Consideration should be given to adjusting Kentucky's 6-second rule to reflect the current guidelines for intersection sight distances. The time gap required for a vehicle to enter the road varies according to the intersection control and movement (right, through or left). For passenger cars at a stop-controlled intersection, these values are 6.5 seconds for right turn and crossing maneuvers and 7.5 seconds for left turns (68). These values are for entering a 2-lane road, and they need to be increased by 0.5 second per additional lane crossed. Additional time gaps for trucks and other intersection control types are provided in the *Policy on Geometric Design for Highways and Streets.*

It should be noted here that the satisfaction of these sight distances is paramount to address safety, and they should be considered in conjunction with the proposed spacing distances. Moreover, these distances should be considered to control if they are longer than the proposed spacing distances.

9.3 Techniques Utilized

The proposed access classification scheme for Kentucky was defined in Chapter 8. Access spacing guidelines are presented here for this classification system. The guidelines are based on research used to establish spacing criteria for other states, spacing requirements of other states, and analysis of geometric guidelines such as stopping sight distance. There are a number of potential techniques that can be used to put access management into effect. *NCHRP Report 420* outlines the most complete list of access management techniques (12). For the purposes of this discussion these techniques can be grouped and summarized as follows:

- ♦ General Spacing Requirements
    - traffic signal spacing,
    - unsignalized access spacing,
    - corner clearance criteria,
    - access separation distances at interchanges,
- ♦ Median Use
    - nontraversable median on undivided highway,
    - replace TWLTL with nontraversable median,
    - closure of existing median openings,

- replace full median opening with median designed for left turns from the major roadway,

♦ Left-turn Alternatives
  - left-turn deceleration lane,
  - left-turn acceleration lane,
  - continuous TWLTL on undivided highway,
  - U-turns as an alternative to direct left turns,
  - eliminate left turns along highways and use a jug handle,

♦ Right-turn Alternatives
  - right-turn acceleration/deceleration lane,
  - continuous right-turn lane,

♦ Driveway Alternatives
  - consolidate driveways,
  - channelize driveways to discourage or prohibit left turns on undivided highways,
  - prevent uncontrolled access along property frontage with a barrier,
  - coordinate driveways on opposite sides of street,

♦ Frontage Roads
  - install frontage road to provide access to individual parcels, and
  - locate/relocate the intersection of a parallel frontage road further from arterial

The following techniques were determined to be the most beneficial and applicable to Kentucky: interchange spacing (grade separated), signalized access spacing, unsignalized access spacing, median use and opening spacing, and corner clearance. Each of these techniques will be discussed in further detail in the following sections and recommended distances will be provided. It should also be mentioned here that the spacing distances recommended in the following sections are presented in increments of 600 feet in order to be compatible with the existing guidelines. While most states have adopted spacing standards based on fractions of a mile, i.e. 660 feet (1/8 mile), 1,320 feet (1/4 mile), etc., the spacing distances recommended for Kentucky utilize 600-foot increments in order to maximize compatibility with existing statutes (KRS 177.135) and regulations (603 KAR 5:120) pertaining to partially-controlled access highways.

9.3.1 Interchange Spacing (Grade Separated)

9.3.1.1 <u>Spacing between Interchanges</u>

The spacing and design of interchanges greatly influences efficiency, safety, and capacity of the travel way. Particularly, the placement of interchanges directly affects the "ability to accommodate high volumes of traffic safely and efficiently through intersections (68)." *A Policy on Geometric Design of Highways and Streets* describes the following warrants for grade separated interchanges as general criteria (68).

- *Design designation*- Roadways that are planned to be fully access controlled requiring grade separations or grade separated interchanges for all intersecting roadways.
- *Reduction of bottlenecks or spot congestion*- Roadways that have insufficient capacity, which can not be relieved with other techniques.
- *Safety Improvement*- Sites that experience a "disproportionate rate of serious crashes"
- *Site Topography*- Where a grade separated intersection is the most economically feasible solution based on the topography of the site.
- *Road-user Benefit*- Sites where road-user costs are high due to delays at congested at-grade intersections.
- *Traffic Volume Warrant*- Use where there are extremely high volumes of traffic present, although there is no specific volume level that would indicate the need for grade separated interchange. Traffic distribution and traffic behavior should also be considered in utilizing this warrant.

It should be noted that the following disclaimer precedes these warrants in the Green Book (68): "An enumeration of the specific conditions or warrants justifying a grade-separated interchange at a given at-grade intersection is difficult and, in some instances, cannot be conclusively stated. Because of the wide variety of site conditions, traffic volumes, roadway types, and grade-separated interchange layouts, the warrants that justify a grade-separated interchange may differ at each location."

Additionally, the Green Book provides general "rule of thumb" interchange spacing criteria for urban and rural areas. In rural areas a minimum interchange spacing of 2 miles is recommended, while 1 mile is recommended for urban areas (68). Shorter spacing may be considered in urban areas when grade separated ramps or collector-distributor roads are to be connected. The more recent AASHTO *Policy on Design Standards—Interstate Systems* recommends the use of 1 mile interchange spacing for urban roads and 3 miles for rural roads (69). Similarly, NCHRP 348 recommends the following minimum spacing criteria (54):

Table 9-1 Grade Separated Interchange Minimum Spacing

	Urban/Suburban	**Rural**
Freeway	1 mile	3 miles
Expressway	1 mile	2 miles
Strategic Arterial	0.5 mile	2 miles

Most states have classified interstates/freeways into a separate classification category. Therefore, they also have separate access spacing, i.e. interchange spacing, criteria. One of these states, Oregon, has published numerous technical documents supporting their access management policies, including spacing criteria (33). Table 9-2 shows the interchange spacing for Oregon. The guidelines for Florida's minimum grade-separate spacing at interchanges are shown in Table 9-3(25). The values used by Florida, replicate those found to be effective in the Oregon document for some of the roadway categories.

Table 9-2 Oregon's Interchange Spacing

<table>
<tr><th>Access Management Classification</th><th>Area</th><th>Interchange Spacing (2)(3)</th></tr>
<tr><td rowspan="2">Interstate (1) and Non-Interstate Freeways (NHS)</td><td>Urban</td><td>3 miles</td></tr>
<tr><td>Rural</td><td>6 miles</td></tr>
<tr><td rowspan="2">All Expressway (NHS), Statewide (NHS), Regional and District Highways</td><td>Urban</td><td>1.9 miles</td></tr>
<tr><td>Rural</td><td>3 miles</td></tr>
</table>

(1) Interstate interchange spacing must be in conformance with federal policy.

(2) For Freeways and expressways, the spacing standards in this table are of planning and design of new interchanges. A major deviation study is required to change these standards, but the deviation is not to violate the spacing requirements in the Interchange Access Management Area Tables 6 through 9 in OAR 734-051-0200.

(3) Crossroad-to-crossroad centerline distance.

Table 9-3 Florida's Minimum Grade-Separated Spacing

Access Class	Area Type	Description	Interchange Spacing
1	Area Type 1	CBD & CBD Fringe for cities in urbanized areas	1 mile
	Area Type 2	Existing Urbanized Areas Other than Area Type 1	2 miles
	Area Type 3	Transitioning Urbanized Areas and Urban Areas other than Area Type 1 or 2	3 miles
	Area Type 4	Rural Areas	6 miles

Similar to the interchange spacing of Florida, Ohio recommends a 2, 4, and 8 mile spacing for urban, suburban, and rural interchanges, respectively. They also indicate that 1 mile is the minimum spacing required for any interchange.

The resulting recommended interchange spacing guidelines for Texas are shown in Table 9-4 (38). Similar to Texas, Washington and New Jersey recommend a general urban and rural interchange spacing of 1 and 2 miles, respectively.

Table 9-4 Texas Minimum Interchange Spacing

Type of Area	Spacing
Fully Developed Urban	1 mile
Urban	1 mile
Rural	2 miles

Missouri also defines minimum interchange spacing requirements in their access management manual (18). The criteria are illustrated in Table 9-5.

Table 9-5 Missouri Interchange Minimum Spacing

Class	Current and Projected Urban Areas	Rural
Interstate/Freeway	2 miles	5 miles
Principal Arterial (A)	2 miles	5 miles
Principal Arterial (B)	2 miles	5 miles
Minor Arterial	Generally not applicable	Generally not applicable
Collector	Generally not applicable	Generally not applicable

The states reviewed, as well as the Green Book, indicate that an area type or land use distinction (between urban and rural) is appropriate for use in setting interchange spacing standards. Similarly, the class system proposed for Kentucky, places interstates into a separate category, which is further categorized into urban and rural. There are also both rural and urban Principal Arterials (Urban I and Rural I) that may require grade separated interchanges. Based on the success and the similarities of the systems of the other states presented here, the proposed interchange spacing distances for Kentucky are shown in Table 9-6. These distances are typically measured between centerlines of cross roads.

Table 9-6 Recommended Kentucky Minimum Spacing Distances for Grade-Separated Interchanges

Access Class	Location	Interchange Spacing
Interstates and Freeways	Urban	1 mile
	Rural	3 miles

Access Class	Interchange Spacing
Urban I	1 mile
Urban II	n/a
Urban III	n/a
Urban IV	n/a
Rural I	2 miles
Rural II	n/a
Rural III	n/a
Rural IV	n/a

9.3.1.2 Spacing for Interchange Termini

Freeway interchanges provide connection between freeways and arterial streets. Their smooth functioning is important to the safety and operational efficiency of the facilities they connect. However, access spacing on arterial streets can have significant impact on operating conditions. For example, a traffic signal at a crossroad that is too close to the upstream free-flowing or yield-control ramp could cause congestion on both the crossroad and the ramp, and even possible spillback onto the freeway mainline. In addition, heavy weaving volume caused by ramp traffic could create safety and operational hazards on the crossroad, especially when the access points are in the vicinity of ramp terminals. Therefore, proper access control along the arterial street within the interchange area is desired.

It is suggested by AASHTO that "control should extend beyond the ramp terminal at least 100 feet in urban areas and 300 feet in rural areas. These distances should usually satisfy congestion concerns. However, in areas where the potential to create traffic problems exists, it may be appropriate to consider longer lengths of access control (68)." The NCHRP Report 420 summarizes the access separations in various states in the United States and Canada (12), as shown in Table 9-7. The minimum distance between the ramp terminus and the first access point in urban areas ranges from 100 to 700 ft; and in rural areas it ranges from 300 to 1,000 ft, as shown in Table 9-8, Figure 9-2, Table 9-9, and Figure 9-3.

Table 9-7 Access Separation Distances at Interchanges

	State	Rural	Urban
1.	Alabama	300 ft to access	100 ft to access
2.	Alberta	425m from signal to access 150m from ramp to access	Same
3.	California	125m minimum distance from ramp to nearest intersection	Same
4.	Illinois	500 to 700 ft	Same
5.	Iowa	200m rural primary highway 100m other road or street	50m urban
6.	Kentucky	300 ft to access	100 ft to access
7.	Maryland	Based on geometric, speeds, volumes, presence of signals and queuing	Same
8.	N. Dakota	AASHTO guidelines	AASHTO guidelines (100ft)
9.	Ohio	600 ft for diamond interchange, 1,000 ft for cloverleaf.	
10.	Oregon	300 ft from frontage road 500 ft from ramp (suggested)	Same
11.	Pennsylvania	AASHTO guidelines (300 ft)	AASHTO guidelines (100ft)
12.	South Carolina	500 ft desirable, 300 ft minimum	300 ft desirable, 150 feet minimum
13.	Texas	AASHTO guidelines (300 feet)	AASHTO guidelines (100ft)
14.	Utah	300 ft to access	150 ft to access
15.	Virginia	200 ft from entrance ramp	Same
16.	West Virginia	300 ft to access	100 ft to access
17.	Washington	300 ft to access	300 ft to access
18.	Wisconsin	1,000 ft to access (500 ft – minor roads)	500 ft to access
19.	Wyoming	300 ft to access	150 ft to access

The NCHRP Report 420 (12) presents a guideline for access separation on crossroads for the interchange area. It is developed based on the practice in the state of Oregon, and it has also been endorsed by the new Access Management Manual (43). The spacing guideline varies based on the type of crossroad. The recommended minimum spacing for freeway interchange areas with multilane crossroads is shown in Table 9-8 and Figure 9-2 and that for an interchange with two-lane crossroads is shown in Table 9-9 and Figure 9-3 (43).

Table 9-8 Minimum Spacing for Freeway Interchange Areas with Multilane Crossroads

Type of Area	Spacing dimension (ft)			
	X	Y	Z	M
Fully developed Urban*	750	2,640	990	990
Suburban/ urban	990	2,640	1,320	1,320
Rural	1,320	2,640	1,320	1,320

* Free flow ramps are generally discouraged in fully developed urban areas and are questionable in suburban/urban areas because pedestrian and bicycle movements are difficult and potentially dangerous.

X = distance to first approach on the right; right in/right out only.

Y = distance to first major intersection. No four-legged intersections may be placed between ramp terminals and the first major intersection.

Z = distance between the last access connection and the start of the taper for the on-ramp.

M = distance to first directional median opening. No full median openings are allowed in non-traversable medians prior to the first major intersection (43).

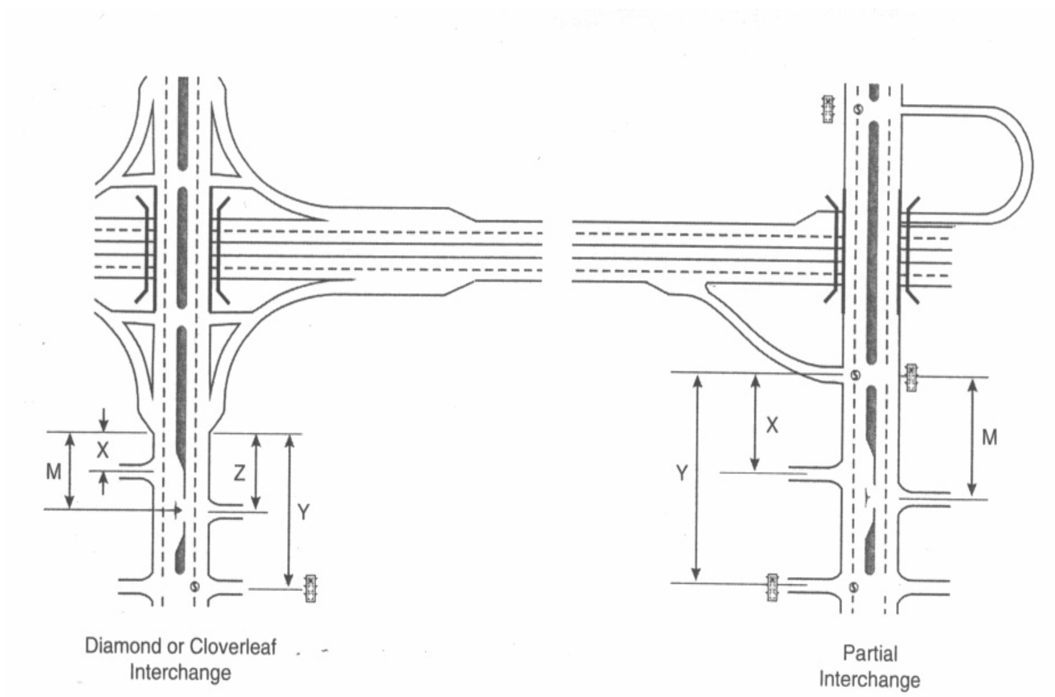

Figure 9-2 Freeway Interchange Areas with Multi-lane Crossroads

Table 9-9 Minimum Spacing for Freeway Interchange Areas with Two-Lane Crossroads

Type of Area	Spacing dimension (ft)	
	X or Z	Y
Fully developed urban	750	1,320
Suburban/urban	990	1,320
Rural	1,320	1,320

X or Z = distance to first access connection from the taper of the off-ramp or on-ramp. This dimension provides for either X or Z but not both, to avoid a four-way connection

Y = distance to first major intersection. No four-legged intersections may be placed between ramp terminals and the first major intersection (43).

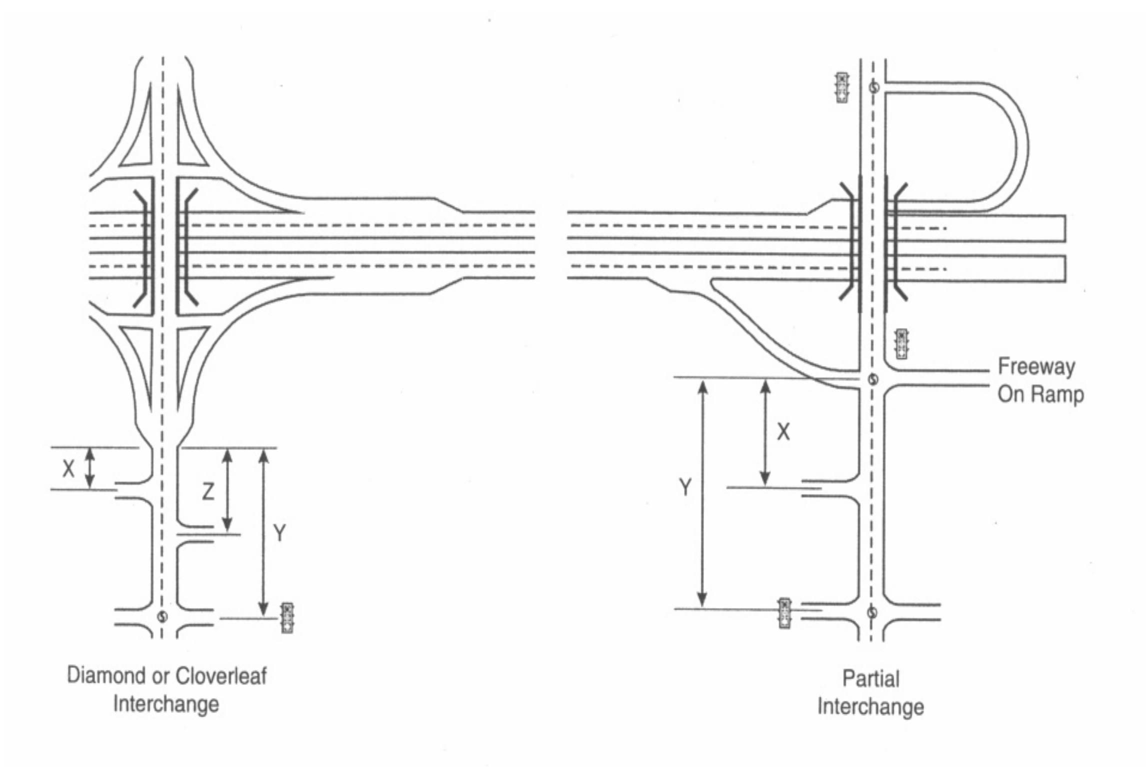

Figure 9-3 Freeway Interchange Area with Two-lane Crossroads

Based on the review, it is recommended that the spacing guideline shown in Table 9-10 be followed in Kentucky. It should be noted that the recommended access spacing for interchange areas is a minimum criterion, and in practice it should be coordinated with other spacing standards along the crossroads.

Table 9-10 Recommended Kentucky Interchange Area Spacing

Access Class	Off ramp right (ft)	Off ramp left (ft)	Off ramp signal (ft)	On ramp taper (ft)
Urban I	900	900	2,400	900
Urban II	600	900	2,400	900
Urban III	600	600	1,200	600
Urban IV	NA	NA	NA	NA
Rural I	1,200	1,200	2,400	1,200
Rural II	1,200	1,200	2,400	1,200
Rural III	NA	NA	NA	NA
Rural IV	NA	NA	NA	NA

9.3.2 Signalized Access Spacing

The spacing of signals on any type of roadway has a substantial impact on the roadway's performance. Signals can account for a great deal of delay and increasing the number of signals along the road often can lead to more congestion. Most of the current research indicates that the use of long spacing between signals is desirable for a proper access management system (1, 12, 70). The primary goal when determining signal spacing is to allow for free-flow timing in both directions of travel. If this is unattainable, efforts should be taken to provide maximum capacity and minimum delay (68). Additionally, location of signals should always be done with attention given to safety and signal visibility. Improper location of traffic control signals may result in (70):

- excessive delay,
- excessive disobedience of the signal indications,
- increased use of less adequate routes as road users attempt to avoid the traffic control signals, and
- significant increases in the frequency of collisions (especially rear-end collisions).

However, the proper location of signals can (70):

- provide for the orderly movement of traffic,

- increase the traffic-handling capacity of the intersection if proper physical layouts and control measures are used, and if the signal timing is reviewed and updated on a regular basis (every 2 years) to ensure that it satisfies current traffic demands,
- reduce the frequency and severity of certain types of crashes, especially right-angle collisions,
- provide for continuous or nearly continuous movement of traffic at a definite speed along a given route under favorable conditions, and
- interrupt heavy traffic at intervals to permit other traffic, vehicular or pedestrian, to cross.

In general signal spacing should accomplish the following two objectives (54):

(1) Relatively uniform traffic signal spacing; and,

(2) Sufficient distances between signals to allow for travel at reasonable speeds.

In order to achieve these goals, states have taken different approaches to regulate signal spacing. For example, states such as Colorado and Florida establish signal spacing for particular classes, while New Jersey outlines minimum bandwidth criteria. The bandwidth of a single signal is approximated by half of the cycle length, thus the spacing is defined as follows (38):

$$\textit{Spacing (ft)} = \frac{\textit{Cycle Length (sec) x Speed (ft/sec)}}{2}$$

The resulting spacing distances are shown in Table 9-11. In addition to New Jersey, South Dakota, Texas, Florida and Colorado base their signal spacing on values similar to those in Table 9-11. Stover and Koepke have completed extensive work in regard to signal spacing and progression, producing tables similar to Table 9-11. They recommend signal spacing of 1,760 ft to 2,640 ft for major arterial streets and 1,320 ft for minor arterials (71).

It should be noted that Texas and New Jersey have established a preferred minimum spacing of 2,640 ft for signalized intersections when conditions allow because shorter spacing distances have been shown to be detrimental to progression. A similar recommendation was made in the *Access Management Manual* (43). Past research indicates that use of shorter distances will produce lower speeds. Shorter cycle lengths in general reduce delays and should be considered as well. NCHRP 348 states that cycle lengths should be as short as possible and cycle lengths of more than 120 seconds should be avoided. These excessively long cycle lengths result in long delays (54). This is reiterated in another technical document utilized in access management development for Oregon (33). According to the Oregon DOT "cycle lengths longer than 120 seconds, even under very high volume conditions, are rarely desirable because the longer red phases stop more vehicles". At this point the increase in stopped delay outweighs the benefits from reducing the lost time. However, given the fact that relatively long cycles tend to be used in practice in order to accommodate turning movements and peak period traffic conditions, long and uniform signal spacing is necessary in order to maintain traffic flow at acceptable speeds. Finally, it should be noted that cycle lengths should be considered based on future traffic volumes when determining the appropriate signal spacing. This is important because many heavily used arterials now use 90-sec to 120-sec cycle lengths, although they were originally designed for 60-sec and 70-sec cycles.

Table 9-11 New Jersey DOT Signalized Intersection Spacing

Cycle Length (sec)	Operating Speed (mph)						
	25	**30**	**35**	**40**	**45**	**50**	**55**
60	1,100	1,320	1,540	1,760	1,980	2,200	2,420
70	1,280	1,540	1,800	2,060	2,310	2,590	2,640
80	1,470	1,760	2,060	2,350	2,640	2,640	2,640
90	1,650	1,980	2,310	2,640	2,640	2,640	2,640
100	1,840	2,200	2,570	2,640	2,640	2,640	2,640
110	2,020	2,420	2,640	2,640	2,640	2,640	2,640
120	2,200	2,640	2,640	2,640	2,640	2,640	2,640

- Units: feet
- The spacing standards for other states that practice access management should also be recognized. For example, the spacing ranges for Minnesota are shown in Table 9-12.

Table 9-12 Summary of Minnesota Signal Spacing

Category	Signal Spacing
Principal Arterials	0.25 - 1 mile
Minor Arterials	0.25 - 0.5 miles
Collectors	0.125 - 0.5 miles

Florida is also among those states that utilize signal spacing as an access management technique. Signal spacing for Florida is shown in Table 9-13 with respect to their class system (1 is the highest level of control and 7 is the lowest).

Table 9-13 Florida Signal Spacing

Class	Signal Spacing (ft)
1	n/a
2	2,640
3	2,640
4	2,640
5	2,640/1,320
6	1,320
7	1,320

Missouri outlines similar signal spacing as follows:

Table 9-14 Missouri Signal Spacing

Roadway Classification	In Current and Projected Urban Areas (ft)	In Rural Areas
Interstate/Freeway	Traffic signals not allowed	Traffic signals not allowed
Principal Arterial (A)	2,640	*
Principal Arterial (B)	2,640	*
Minor Arterial	2,640	*
Collector	1,320	*

*Spacing of signals should generally be isolated (1 mile), so that spacing and progression should not be a problem.

Montana defines spacing and a percentage bandwidth for each of their roadway classes, as shown in Table 9-15.

Table 9-15 Montana Signalized Spacing Guidelines

Category	Cross Section	Area	Signal Spacing (ft)-Bandwidth
NHS	Undivided	Rural-very low volume	NA
		Rural	2,640-45%
		Intermediate	2,640-45%
		Developed Access	1,320-40%
	Divided	Intermediate	2,640-45%
		Developed Access	1,320-40%
Primary	Undivided	Rural-very low volume	NA
		Rural	2,640-40%
		Intermediate	2,640-40%
		Developed Access	2,640-35%
	Divided	Intermediate	2,640-40%
		Developed Access	1,320-35%

Based on the research information and the success of those states using signal spacing as an access management technique the spacing standards in Table 9-16 are suggested for use in Kentucky.

Table 9-16 Suggested Kentucky Signal Spacing

Class	Signal Spacing (ft)
UI	2,400
UII	2,400
UIII	1,800
UIV	NA
RI	4,800
RII	2,400
RIII	2,400
RIV	NA

Due to the rural nature of much of Kentucky and the high travel speeds typical of rural areas, it is suggested that signals be used sparingly in rural areas. If a signal becomes necessary, based on MUTCD warrants or other engineering judgment, it would typically be used in an isolated manner, rather than in series with other signals, so spacing should not become a problem. For Urban IV (UIV) roads no signal spacing is provided because these roads typically carry low volumes and signals are not warranted. However, if a signal becomes necessary, the minimum spacing should be 1,200 feet.

Another issue that should be considered with respect to signalized intersection spacing is the potential for removal of unwarranted or unnecessary signals. Existing signals that do not conform to spacing standards should be periodically reviewed to determine their current necessity. Strong consideration should be given to removing non-conforming signals that do not meet MUTCD warrants. It is also recommended that when access is considered for a property, traffic signals in the vicinity should be examined and evaluated. This evaluation can lead to recommending the removal of unnecessary traffic signals to allow for a better traffic flow and improved access to the property.

9.3.3 Unsignalized Access Spacing

There are numerous advantages to regulating driveway and other unsignalized intersections. Regardless of whether a state utilizes access management, most have some type of driveway permitting process. A survey of state and local agencies found that programs that evaluate driveway access can:

- Reduce the number of crashes,
- Improve the operation of the roadway (LOS), and
- Improve site design (71).

Unsignalized access points are very common and can be very complex. Unsignalized access points at different types of activity centers may produce large volumes of traffic or very little traffic. It is also important to recognize that the speed of roadways can greatly influence the effect of these intersections. The greater the speed, the more adverse the effects can be. However, there is a need to strike a balance with adopted spacing standards. While safety and efficiency should be a key to determine spacing values, consideration must also be given to the impact that excessively large spacing could have on economic development. In addition to the spacing standards, there are a number of key concepts that can be integrated to lessen the functional degradation caused by numerous access points. For example, the use of frontage and backage roads, joint access, cross access, and shared driveways on major roads, where possible, may alleviate a number of problems (18). Additionally, when possible, direct access should be provided via local streets or collectors instead of arterials.

Currently, there is no specific, universal method of establishing spacing criteria for unsignalized intersections. There are a variety of approaches that include spacing based on speed (Colorado and Oregon), right turn overlap (New Jersey), and type of traffic generator (Oregon and Ohio) (54). Additionally, other states use a combination of factors. For example, in Kansas the spacing is related to the speed and the type of access. To further examine the practice of various states a number of examples are presented here.

Oregon completed a great deal of research for establishing unsignalized intersection spacing (33). The recommended distances for unsignalized intersection spacing are shown in Table 9-17.

Table 9-17 Oregon Unsignalized Access Spacing Criteria

Highway Functional Class	Lanes	Area	Approach/Driveway	
			Type	Spacing
Major Arterial	Multi Lane	Rural	rt turn	1,320 ft
		Urban	rt turns	990 ft
		Fully Developed	rt turns	660 ft
	Two-Lane	Rural	rt turn	1,320 ft
		Urban	rt turns	990 ft
		Fully Developed	rt turns	660 ft
Minor Arterial	Multi Lane	Rural	lt / rt turns	660 ft
		Urban	lt / rt turns	660 ft
		Fully Developed	lt / rt turns	660 ft
	Two-Lane	Rural	lt / rt turns	660 ft
		Urban	lt / rt turns	660 ft
		Fully Developed	lt / rt turns	660 ft
Major Collector	Multi Lane	Rural	lt / rt turns	660 ft
		Urban	lt / rt turns	330 ft
		Fully Developed	lt / rt turns	160 ft
	Two-Lane	Rural	lt / rt turns	660 ft
		Urban	lt / rt turns	330 ft
		Fully Developed	lt / rt turns	160 ft

The following statements taken from Oregon's technical document explain how these spacing distances were derived. "It is recommended that on major arterials that capacity and safety are both concerns so the maximum egress capacity and decision sight distance should be provided. For the minor arterial the safety is a greater concern than capacity so decision sight distance should be used to set the spacing. For major collectors, the single conflict overlap criterion is recommended since it provides a reasonable measure of safety and available access is of more concern than capacity for these facilities (33)." South Dakota provides a minimum unsignalized access spacing distance, as well as an acceptable access density (35). The following Table 9-18 defines both. Table 9-19 shows the minimum driveway spacing values used in Missouri.

Table 9-18 South Dakota Unsignalized Access Criteria

Access Classification	Minimum Unsignalized Access Spacing (ft)	Access Density
Interstate	NA	NA
Expressway	2,640	2 per mile
Free Flow Urban	1,320	4 per mile
Intermediate Urban	660	1 access/block face right in/right out preferred
Urban Developed	100	2 accesses/block face
Urban Fringe	1,000	5 accesses/side/mile
Rural	1,000	5 accesses/side/mile

Table 9-19 Missouri Driveway Access Spacing

Roadway Classification	In Current and Projected Urban Areas (ft)	In Rural Areas (ft)
Interstate/Freeway	No driveways are allowed	No driveways are allowed
Principal Arterial (A)	660	1,320*
Principal Arterial (B)	440	660*
Minor Arterial	330	440*
Collectors	220	330*

* "The urban standard may be applied in developed areas that are not urban, for example, cities with populations under 5,000. On collectors in cities with population under 5,000, the recommended minimum standard is 220 feet (same as the urban standard)."

Additionally, Table 9-20 outlines the connection spacing standards for Florida by class.

Table 9-20 Florida Connection Spacing

Access Class	Connection Spacing (ft)	
	>45 mph	<45 mph
2	1,320	660
3	660	440
4	660	440
5	440	245
6	440	245
7	125	

Ohio bases driveway spacing on the posted speed limit. Table 9-21 shows the minimum driveway spacing values.

Table 9-21 Ohio Minimum Driveway Spacing Values

Posted Speed	Minimum Spacing (ft)
25	155
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645

The Ohio spacing values duplicate the AASHTO design stopping sight distances (utilizing the customary 2.5 sec. brake reaction distance and 11.2 ft/s^2 deceleration rate) (68). In Colorado, access spacing is based on the horizontal and vertical sight distance. One key change that should be noted is the use of a 4.25 ft height of object for sight distances, which is substantially greater then the typical 2 ft height recommended by the Green Book (68, 24).

In addition to the states reviewed, NCHRP 348 also offers recommendations for driveways. Their recommendations are defined in regard to three sizes of traffic generators. They are "(1) minimum use generator -- single-family residences or other activities that generate less than 50 vehicle trips per day or five trips in the peak hour (total, both directions); (2) minor generator -- 51 to 5,000 vehicle trips per day or less than 500 trips in the peak hour (total, both directions); and (3) major generator -- more than 5,000 vehicle trips per day or 500 trips in the peak hour (total, both directions) (54)." These suggestions are shown in Table 9-22.

Table 9-22 NCHRP 348 Unsignalized Access Recommendations

Access Level	Assumed Speed (mph)	Minimum Generator (ft)	Minor Generator (ft)	Major Generator (ft)
Urban				
3	35	140-175	245-280	315-350
4	35	140-175	245-280	315-350
5	30	90-120	150-180	210-240
6	30	30-60	120-150	150-180
Suburban				
3	45	180-225	315-360	405-450
4	45	180-225	315-360	405-450
5	35	105-140	175-210	245-280
6	35	35-70	140-175	175-210
Rural				
3	50	200-250	350-400	450-500
4	45	180-225	315-360	405-450
5	45	135-180	225-270	315-360
6	40	40-80	160-200	200-240

NCHRP 348 also enumerates some general variables to be used in setting access standards for unsignalized access points. These variables include (54):

- Speed factors including posted or operating speed, stopping sight distance, and distance to reduce collision potential due to overlapping right turns
- Roadway factors including functional class, access level, median, and driveway width
- Driveway generator in regard to the volume of trips generated
- Development density (urban, rural, suburban)

From the examples and recommendations provided, a number of general comments can be made.

- Access spacing should be greater for higher-class roadways.
- Access spacing should be greater for rural roadways.
- Approach type (commercial, agricultural, residential) can dictate spacing.

- Higher speeds and volumes increase the spacing.
- At a minimum sight distances should be met.

Based on the information presented thus far, suggested unsignalized access spacing criteria for use in Kentucky are presented in Table 9-23.

Table 9-23 Suggested Kentucky Unsignalized Spacing

Class	Unsignalized Spacing (ft)
UI	1,200/600
UII	450
UIII	300
UIV	150
RI	1,200
RII	600
RIII	450
RIV	150

There are two values provided for the Urban I (UI) classification to reflect potential differences in roadways within this category. Based on the access classification described in the previous section, some of these roads would be urban arterials with speeds greater than 45 mph. To preserve the function of mobility for such higher speed roadways, it was considered appropriate to increase the unsignalized intersection spacing to match that of RI category. In effect, this recommendation would preserve the 1,200 ft access spacing that presently exists for roadways in this classification that have partial access control.

9.3.4 Median Type and Opening Spacing

Medians are another important component of access management. In general median openings are provided at all signalized at-grade intersections and at unsignalized intersections of arterial and collector streets. Additionally, "median openings may be provided at driveways, where they will have minimum impacts on roadway flow (54)." The use of medians and appropriate opening spacing leads to improved safety, efficiency, and aesthetics. Three primary benefits of medians commonly referred to are (72):

(1) Vehicular safety - medians help reduce crashes associated with left-turning maneuvers and also tend to lessen the effect of headlight glare from opposing traffic.

(2) Pedestrian safety - medians provide a refuge for pedestrians crossing roadways.

(3) Vehicular efficiency - medians can provide storage for turning traffic, removing these vehicles from through traffic which can improve highway operational functions.

A number of states practicing access management have median opening criteria for urban and rural highways with spacing distances ranging from 330 ft to 2,640 ft (54). Additionally, the type of roadway should be recognized when determining whether or not to use medians. Medians are typically more important on higher-class roadways. Since these roadways often serve areas of high activity, there is often a greater need for pedestrian and turning vehicle refuge. In higher-class roadways they also allow for future growth and provide a recovery area for out of control vehicles; therefore, medians should be used on arterials carrying four or more lanes (68).

In addition to simply regulating median opening spacing, a number of states differentiate between full and directional openings. Directional openings allow turning maneuvers in only one direction, whereas full openings allow unrestricted turning movements. This is illustrated by the guidelines used in Florida. Florida provides a great deal of information concerning median use in their "Median Handbook (72)." This is published to supplement their spacing criteria, which are outlined in Table 9-24. (Restrictive median treatment refers to a non-traversable median, or one with some physical barrier.)

Table 9-24 Florida Median Criteria

Access Class	Median Treatment	Median Opening Spacing (ft)	
		Directional	Full
2	Restrictive with service roads	1,320	2,640
3	Restrictive	1,320	2,640
4	Non-restrictive	NA	NA
5	Restrictive	660	2,640 (<45 mph, 1,320)

Missouri utilizes median requirements similar to Florida, as detailed in Table 9-25.

Table 9-25 Missouri Median Spacing

Roadway Classification	In Current and Projected Urban Areas	In Rural Areas
Interstate/Freeway	No median openings allowed	No median openings allowed
Principal Arterial (A)	2,640 ft 1,320 ft (directional)	2,640 ft (full, > 45 mph) 1,320 ft (full, < 45 mph)
Principal Arterial (B)	1,320 ft (full) 660 ft (directional)	2,640 ft (full, >45 mph) 1,320 ft (full,< 45 mph)
Minor Arterial	1,320 ft (full) 660 ft (directional)	1,320 ft (full) at all speeds
Collector	Medians generally not used	Medians generally not used

Additionally, Missouri defines situations where median openings are not permissible:

- Interstates or other freeways,
- Within the functional area of an interchange,
- Within the functional area of an intersection between two public roads,
- Locations that have high accident rates, and
- Places with inadequate sight distance (18)

Missouri also defines guidelines used to determine the median type to be used (18). These guidelines are in Table 9-26.

Table 9-26 Median Types by Class

Roadway Classification	In Current and Projected Urban Areas	In Rural Areas
Interstate/Freeway	No median openings	No median openings
Principal Arterial (A)	Use a raised median when current and projected traffic exceeds 28,000 AADT	Use flush median instead
Principal Arterial (B)	Use a raised median when current and projected traffic exceeds 28,000 AADT	Use flush median instead
Minor Arterial	Use a raised median when current and projected traffic exceeds 28,000 AADT	Use flush median instead
Collector	Generally not applicable due to low traffic volumes	Generally not applicable due to low traffic volumes

South Dakota, which uses a somewhat different classification system, utilizes the following median opening spacing distances (35).

Table 9-27 South Dakota Median Criteria

Access Classification	Median Opening Spacing (ft)
Interstate	NA
Expressway	Full: 2,640, Directional: 2,640
Free Flow Urban	Full: 2,640, Directional: 1,320
Intermediate Urban	Full: 2,640, Directional: 1,320
Urban Developed	1320
Urban Fringe	Full: 2,640, Directional: 1,320
Rural	NA

Montana also utilizes median spacing as a component of access management. Their spacing criteria, shown in Table 9-28, resemble those of South Dakota and Missouri.

Table 9-28 Montana Median Requirements

Category	Cross Section	Area	Median Opening Spacing (ft)
NHS	Undivided	Rural-very low volume	NA
		Rural	NA
		Intermediate	NA
		Developed Access	NA
	Divided	Intermediate	Full: 2,640 Directional: 1,320
		Developed Access	Full: 1,320 Directional: 660
Primary	Undivided	Rural-very low volume	NA
		Rural	NA
		Intermediate	NA
		Developed Access	NA
	Divided	Intermediate	Full: 2,640 Directional: 1,320
		Developed Access	Full: 1,320 Directional: 660

Texas, which has proposed an access management program, utilizes the following median criteria based on work completed in Florida. Their median standard is shown in Table 9-29.

Table 9-29 Texas Median Criteria

Category	Minimum Median Spacing Criteria (ft)	
	Directional	**Full**
AC 1	Full Median- No Openings	Full Median- No Openings
AC 2	1,320	2,640
AC 3	1,320	2,640
AC 4	Traversable Median	Traversable Median
AC 5	660	2,640 (≥45 mph) 1,320 (<45 mph)
AC 6	Traversable Median	Traversable Median
AC 7	330	660

In addition to the criteria from other states, the following guidelines from NCHRP 348 should also be considered (54):

- "The spacing of median openings for signalized driveways should reflect traffic signal coordination requirements and the storage space needed for left turns.
- The spacing of median openings for unsignalized driveways should be based on the values suggested in Table 9-30. Ideally, spacing of breaks should be conducive to signalization.
- Median openings for left-turn entrances (where there is no left-turn exit from the activity center) should be spaced to allow sufficient storage for left-turning vehicles.
- Median openings at driveways can be subject to closure where volumes warrant signals, but signal spacing would be inappropriate.
- Median openings should be set far enough back from nearby signalized intersections to avoid possible interference with intersection queues.
- In all cases, storage for left turns must be adequate."

Table 9-30 NHCRP 348 Median Opening Suggestions

Access Level	Urban (ft)	Suburban (ft)	Rural (ft)
1	NA	NA	NA
2	NA	NA	NA
3	NA	NA	NA
4	660	660	1,320
5	660	*	*
6	330	660	1,320
7	-	-	-

*Based on Signal Spacing

Based on the information provided, the following median criteria as shown in Table 9-31 are suggested for use in Kentucky. The **X's** indicate the desirable median type for each class of roadway, while the spacing indicates the minimum distance between median openings.

Table 9-31 Suggested Kentucky Median Criteria

Category	Desirable Median Type		Opening Spacing (ft)	
	Traversable	Non-traversable	Full	Directional
Urban I		**X**	2,400	1,200
Urban II	**X**	**X**	2,400	1,200
Urban III	n/a	**X***	1,200	600
Urban IV	n/a	n/a	n/a	n/a
Rural I		**X**	2,400	2,400
Rural II	**X**	**X**	1,200	1,200
Rural III	n/a	**X***	1,200	600
Rural IV	n/a	n/a	n/a	n/a

* Recommended for multi-lane facilities.

9.3.5 Corner Clearance

The use of minimum corner clearances, the distance between an intersection and the nearest driveway, is another important technique that can be used to enforce access management (12). Use of corner clearances removes driveways from the functional area of at-grade intersections. "Inadequate corner clearances can result in traffic-operation, safety, and capacity problems (12)".

A number of specific problems as outlined by NHCRP 420 include (12):

- Through traffic blocked by vehicles waiting to turn into a driveway.
- Right or left turns into or out of a driveway (both on artery and crossroad) are blocked.
- Driveway traffic is unable to enter left-turn lanes.
- Stopped vehicles in left-turn lanes impact driveway exit movements.
- Traffic entering an arterial road from the intersecting street or road has insufficient distance.
- The weaving maneuvers for vehicles turning onto an artery and then immediately turning left into a driveway are too short.
- Confusion and conflicts resulting from dual interpretation of right-turn signals.

In order to avoid these problems adequate distance must be provided to ensure driveways are removed from an intersection's functional area. According to the AASHTO *Green Book* (68), an intersection is defined by both the physical and functional area. The functional area should include all auxiliary lanes, as well as the physical intersection area up and down stream of the intersection. The functional area can be established by considering the following three components: perception-reaction distance, maneuver distance, and the queue storage distance (68). The following two figures, Figure 9-4 and Figure 9-5, derived from the Green Book illustrate the physical and functional areas of the intersections.

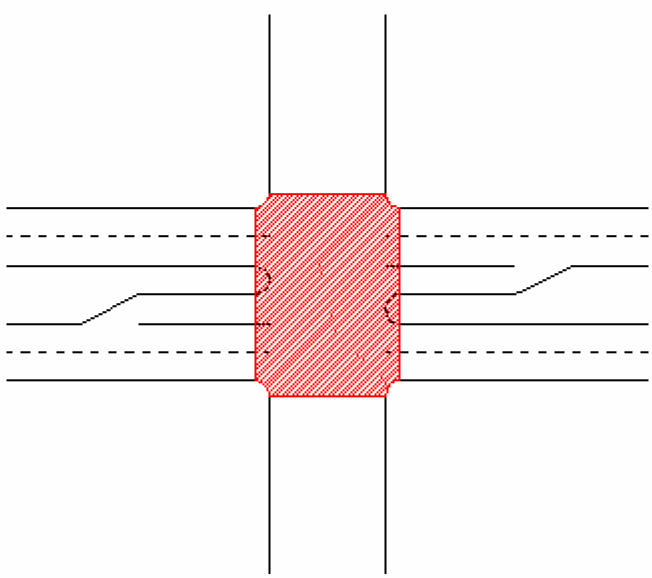

Figure 9-4 Intersection Physical Area

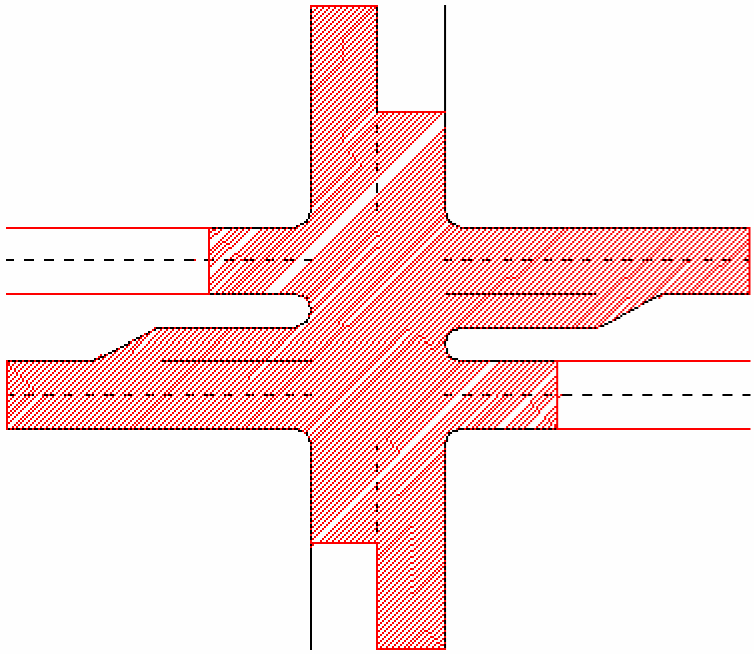

Figure 9-5 Intersection Functional Area

While the need for adequate corner clearance is very evident, criteria for determining minimum corner clearance distances can be complex. There are four types of intersection clearance that should be evaluated (Figure 9-6) based on issues such as perception reaction, queue storage, functional intersection area, stopping sight distance, and right-turn conflict overlap. Two of these are along the major road and have the potential to influence operation along this roadway. Inadequate distance for either A and B could impact traffic flow along the major road and driveway operation. Similarly, driveways on the minor road have the potential to affect the operation of both roads. Turning vehicles from the major road could be impacted and there is the potential that vehicles would not be able to complete their movements. The traffic on the minor road could potentially face the same problems as those noted for the driveway distance A along the major road. It is therefore imperative to examine the potential influence of any of these driveways on the operation of the intersection, and it is recommended that a detailed traffic engineering analysis of the area should be undertaken prior to any driveway approval that may have the potential to negatively impact intersection operation.

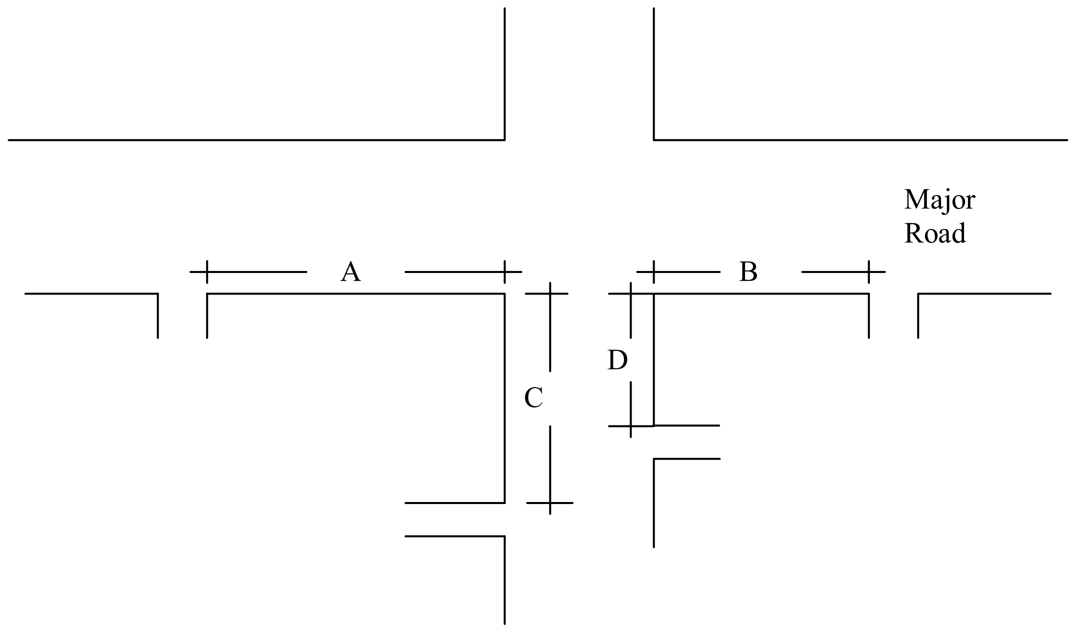

Figure 9-6 Corner Clearance Types

A number of states utilize corner clearance standards in their access management plan. Some examples of those states are provided here.

The requirements for corner clearance in South Dakota are associated with posted speed limits. The corner clearances upstream of major intersections are provided in Table 9-32.

Table 9-32 South Dakota Minimum Upstream Corner Clearance

Speed (mph)	Corner Clearance (ft)
30	200
35	225
40	250
45	280
50	350
55	425

Texas and Missouri duplicate their spacing standards for driveways for corner clearance criteria. For reference they are shown here in

Table 9-33 and Table 9-34. (Texas utilizes the stopping sight distance for driveway separation).

Table 9-33 Texas Corner Clearance Requirements

Design Speed	Driveway Spacing (ft)
25	155
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645
70	730

Table 9-34 Missouri Corner Clearance Criteria

Roadway Classification	In Current and Projected Urban Areas	In Rural Areas
Interstate/Freeway	No driveways are allowed	No driveways are allowed
Principal Arterial (A)	660 feet	1,320 feet*
Principal Arterial (B)	440 feet	660 feet*
Minor Arterial	330 feet	440 feet*
Collectors	220 feet	330 feet*

* "The urban standard may be applied in developed areas that are not urban, for example, cities with populations under 5,000. On collectors in cities with population under 5,000, the recommended minimum standard is 220 feet (same as the urban standard)."

The use of driveway spacing values seems to be a logical approach for establishing corner clearance requirements since it ensures uniform spacing between access points. With this in mind, it is recommended that the corner clearance criteria used for Kentucky should mirror the spacing requirements for unsignalized intersections. The following table reiterates these values.

It should be noted that these criteria should be considered as appropriate for relatively simple and straightforward applications only. A detailed analysis of the entire area is recommended prior to granting any driveway permit in the vicinity of an intersection that may have the potential to impact the overall level of service of the intersection. This analysis should examine the operational level of the intersection influence area. It is also imperative to eliminate potential conflicts between turning vehicles at the intersection and vehicles using the driveways. Therefore, it is recommended that driveways should not be allowed within the limits of a turning lane at an intersection in cases where the length of the turning lane (including taper) is greater than the values in Table 9-35. Finally, the 1,200 ft distance shown for Urban I (UI) category should be used in roadways with speed limits greater than 45 mph (as per discussion in the unsignalized intersection spacing 9.3.3).

Table 9-35 Kentucky Suggested Corner Clearances

Class	Corner Clearance (ft)
UI	1,200/600
UII	450
UIII	300
UIV	150
RI	1,200
RII	600
RIII	450
RIV	150

9.4 Conclusions

The research and the practices of the states reviewed show a number of commonalities in regard to the access standards used for access management. Since there are a number of different access classification systems, the standards are somewhat different for each state, but the logic used to derive the values tends to be the same. Based on the classification system derived for Kentucky and the spacing guidelines provided in the preceding sections, Table 9-36 shows the suggested access management spacing standards for Kentucky.

It should be understood that the access management standards recommended here are not intended to be applied retroactively. They will apply to requests for new access and to changes in existing access. Legal access that exists at the effective date of the new access management policy would be allowed to continue, subject to change in use regulations. Further, in cases where the Cabinet formally negotiates access modifications with property owners in conjunction with a highway improvement project, it is expected that such negotiations would take precedence over the spacing standards shown in Table 9-36.

Table 9-36 Suggested Access Management Spacing Standards for Kentucky

Access Class	Location	Interchange Spacing
Interstates	Urban	1 mile
	Rural	3 miles

Access Class	Typical Functional Class	Interchange Spacing (ft)					Signalized Intersection (ft)	Unsignalized Intersection (ft)	Median Type		Median Opening (ft)		Corner Clearance (ft)[8]
		To Interchange	A[1]	B[2]	C[3]	D[4]			Traversable	Non-traversable	Full	Directional	
Urban I	Principal Arterial	1 mile	900	900	2400	900	2400	1200/600[6]		X	2400	1200	1200/600[6]
Urban II	Minor Arterial	NA	600	900	2400	900	2400	450	X	X	2400	1200	450
Urban III	Collector	NA	600	600	1200	600	1800	300	NA	X[7]	1800	600	300
Urban IV	Local	NA	NA	NA	NA	NA	NA[5]	150	NA	NA	NA	NA	150
Rural I	Principal Arterial	2 miles	1200	1200	2400	1200	4800	1200		X	2400	2400	1200
Rural II	Minor Arterial	NA	1200	1200	2400	1200	2400	600	X	X	1200	1200	600
Rural III	Collector	NA	NA	NA	NA	NA	2400	450	NA	X[7]	1200	600	450
Rural IV	Local	NA	NA	NA	NA	NA	NA	150	NA	NA	NA	NA	150

Notes:
1. Distance to first approach on the right from the off ramp gore; right in/ right out only
2. Distance to first left turn from the off ramp gore in divided highways.
3. Distance to first major intersection (signal) from the off ramp gore; no four leg intersection between ramp terminals and this intersection
4. Distance to last access connection and start of on ramp taper
5. Not recommended due to typically low volumes; if necessary, 1,200 ft spacing should be used
6. For roadways with speed limit greater than 45 mph use 1,200 ft
7. Recommended for multi-lane facilities
8. Distances shown should be used if greater than turning bay length; a detailed study of the area is recommended prior to driveway approval.

9.5 Recommended Practice

In addition to the recommended access management spacing distances, a set of recommended practices that have the potential to improve flow and increase safety are discussed in this section.

(1) A fundamental assumption for all recommended spacing distances is that they meet sight distance requirements. Requirements for safety and visibility supercede the distances in Table 9-36.

(2) In cases where access is examined due to a roadway reconstruction, existing signals should be revaluated to determine whether their presence is still warranted. Removal of unnecessary and/or unwarranted signals has the potential to improve flow and increase capacity.

(3) Corner properties that potentially could have access to roadways with different access classes should be encouraged to obtain access along the roadway with the lower class. This would allow for undisturbed traffic flow along the roadway with the higher class and reduce potential conflicts.

(4) Driveways of adjacent properties should be consolidated whenever feasible. This approach will reduce the number of access points and thus improve flow and safety.

(5) Detailed studies for driveway permits within the influence area of an intersection should be conducted to ensure undisturbed operations at the intersection. Particular attention should be given to cases where turning lanes are present to ensure that the driveway will be well beyond the limits of those lanes.

(6) Access to outparcels for a development site should be provided within the development, and direct access from the adjoining street or highway should not be allowed. This will ensure reduction of access points and help improve flow and safety along the roadway serving the development.

(7) For corner properties with access to a major highway (Urban and Rural I or II), a non-traversable median is recommended to eliminate left turns entering and exiting the property.

(8) For corner properties, locating access as far as from the intersection as possible is desirable to reduce conflicts from overlapping movements.

(9) Elimination of left-turn egress and ingress is recommended for driveways within the influence area of an intersection along undivided major highways.

10 ACCESS MANAGEMENT VARIANCE PROCEDURE

As indicated by most access management systems, it is not possible to anticipate and cover all the conditions that will be encountered during its administration. Some form of flexibility is appropriate in situations where the literal application of a standard is inappropriate. Such is the case with other regulations and ordinances that affect private land including land use zoning and subdivision regulation wherein variances are permitted (given a prescribed process, procedure, and set criteria). The need typically results from situations that may include the unusual shape of a land parcel, topographical features, pre-existing development or other special situations specific to the site. The goal of access management is to maintain consistent and uniform application of the standards, yet the potential cost of litigation (to test reasonableness) and negative impact to the overall effectiveness of the regulation without consistent criteria based variance provisions could be substantial.

10.1 Process

Allowing for variances in access management standards requires that any deviations be handled with a consistent review and decision process. Applications for variance must be subjected to the same review, analysis, and decision criteria or the results will be subject to being declared arbitrary and capricious by the courts, if challenged. Variances may be of a minor or major nature, with the latter requiring a more extensive procedure. In addition, an 'appeal' process may be built into the administrative procedures for access management to assure due process prior to a property owner resorting to judicial recourse (and possibly reduce that occurrence). Literature suggests that a variance procedure be defined by: a statement of purpose; guiding principles; guidelines for review of deviations; and a description of the variance process. Briefly, these are outlined below:

- <u>Purpose</u> (as an example) - the variance procedure is to provide consistent application of engineering decisions involving deviations from adopted access standards.
- <u>Guiding Principles</u> (may include some of the following)- traffic safety is of paramount importance and system efficiency and integrity are of vital importance especially on higher functionally classified roadways; the higher the class of the roadway, the less the deviation that should be allowed; all deviations from the standards need to be approved by a professional engineer knowledgeable in traffic operations and access

management; the 'burden of proof' rests with the applicant requesting the deviation; and the same requirements and procedures for approval of deviations shall apply to all (DOT, municipalities, counties, businesses, developers, and private individuals).

- Guidelines for Review (may include some of the following) -
  - deviations shall not be considered until feasible options for meeting access standards are explored;
  - a complete analysis of the proposed deviation should include: 1) adequacy of maneuvering distances, 2) gap availability in the opposing traffic stream, 3) ability to accommodate future growth and increasing traffic volumes;
  - conditions that may be viewed favorably in evaluating a deviation include: 1) opportunities to accommodate joint access serving two or more traffic generators, 2) existence of un-relocatable control points such as bridges, parks, cemeteries, or unique natural features where application of a standard would result in a safety, maneuvering or traffic operation problem.

  Note: a minor deviation might be defined as those that are of such inconsequential nature that the proposed access placement substantially complies with the purpose and intent of the access standards. Such a deviation might be defined measurably by a percentage (5% or 10%) or by a magnitude (less than 100 ft. or 200 ft.) depending on the nature of the standard.
- Variance Process (description would include) - application requirements, steps and timing of reviews, staff roles and responsibilities, organizational assignment (central and/or district), and appeal procedure.

10.2 A Structured Approach to Variances

The following provides a sketch plan of a suggested process for variance at the state level for access management. The goal is to keep an access management program from being so rigid that it could not pass the test of reasonableness or so variable that it could be considered arbitrary. A two-level review process is suggested when an application exceeds the adopted roadway access standards. It specifies two levels of information/analysis being required with different decision processes. The level of review is determined by the planned scale of development to be accessed and the consequent traffic to be generated. Thorough documentation of the applicant's information and the professional staff's analysis is required along with the record of decision.

Any suggested decision process needs to be adjusted to the context of the state's access management program, as implemented, with attention to staffing and organization, including specified roles and responsibilities. The program must be a consistent package of activities that work together and are supported with appropriate administrative regulations. A starting point for that part of the package regarding variance is provided below.

10.2.1 A Minor Deviation: Level 1 Waiver

- Types of Situations-- Small-scale projects with trips fewer than 75 per day requesting a deviation from the standard within specified parameters (e.g. less than 100 feet or up to 5%).
- Information Required-- Basic information (location and vicinity map, size/type of development, trip generation per day and for peak hours, and opening date) and a site plan.
- Method of Decision-- A district level access management professional makes the determination after review of the facts and on-site verification, and the central office (access management program manager) provides a confirmation review prior to releasing the waiver decision to the applicant. The reason for denial would be that a reasonable alternative could be provided.

10.2.2 A Major Deviation: Level 2 Waiver

- Types of Situations-- Large scale projects generating 75 trips or more per day or any project requesting a deviation from the standard of 100 feet or more or 5% or more, as appropriate to the standard.
- Information Required-- Basic information (location and vicinity map, size/type of development, trip generation per day and for peak hours, and opening date), site plan and a traffic impact study (if project is generating 100 trips or more in the peak hour when fully developed).
- Method of Decision-- A central level access management panel makes the determination after review of the facts to include on-site verification by a district level

access management professional. The panel should have a cross-functional make-up to include at least the Directors of Planning, Design, and Traffic Operations. The panel to consider a second level waiver would be chaired by the appropriate assistant state highway engineer with the access management program manager presenting the facts and analysis and documenting the record of decision. The district level access management program manager would be responsible for working with the applicant to insure that the needed information is contained in the request. In cases where traffic impact studies are required, it is suggested that these be conducted only by consultants that are prequalified by the Cabinet to perform this type of work or by consultants that are retained by the Cabinet (but paid by the property owner/developer) for this purpose. This would help insure consistent analytical procedures and quality of work and eliminate potential bias. The reason(s) for denial would be that reasonable alternative access could be provided and/or the requested access would detrimentally impact roadway safety/operations.

In addition, an appeal procedure should be established that would be the final executive branch decision level for an applicant that had received a denial of a departmental waiver (Level 1 or 2). It is suggested that the basis for such an appeal be the demonstration of an unusual hardship on the property owner, where no other feasible alternatives existed, or a potential loss of a substantial economic development opportunity to a community. This appeal deliberation would deal with highly unusual circumstances that would have to be weighed against the need to protect the safety of the roadway users and the community. Providing the information to support the appeal request would be the responsibility of the applicant and, if involving community economic development considerations, could be further supported by a local official. This appeal might be heard by the Secretary, Deputy Secretary, and the State Highway Engineer or by a specially appointed appeals board or officer. Some states use a board or officer to lessen the possibility of an applicant's attempt to unduly influence the decision and to lessen the perception of bias.

11 ACCESS MANAGEMENT IMPLEMENTATION PLAN

This research project has attempted to increase awareness of the potential benefits of access management for Kentucky and to lay the groundwork for implementation of an Access Management Program within the Kentucky Transportation Cabinet. The implementation process will involve several steps, which are discussed in the sections that follow.

Form Access Management Implementation Task Force - A key initial, executive level action required in the implementation process will be the formation of an Access Management Implementation Task Force. This task force will pick up where this research project ends and continue the effort through formal initiation of the Cabinet’s Access Management Program. In general, this task force will be charged with the responsibility for working out the many details that remain to be dealt with, for marketing and public involvement, and for defining program parameters including procedures and roles/responsibilities. The task force should be diverse and include individuals representing primary stakeholder groups - both within and outside the Cabinet - that have an interest in access management issues. Broad representation on the task force is recommended in order to build a strong base of support for access management and to uncover potential opportunities or problems that could arise in relation to program alternatives. Representation from the following offices/functions within the Cabinet is recommended: State Highway Engineer’s Office, Office of General Counsel, Division of Highway Design, Division of Traffic, Division of Planning, Division of Multimodal Programs, Central Office Permits Branch, District Office Preconstruction, District Office Permits, and District Office Planning. The task force should be assisted by the Kentucky Transportation Center, and it is recommended that representation from outside the Cabinet also be considered. The following groups/agencies should be considered for possible representation on the task force: FHWA, a local planning and zoning office, an Area Development District, a Metropolitan Planning Organization, the Kentucky Chapter of the American Planning Association, a consulting engineering firm, and a non-profit agency with an interest in highway and access related issues (such as Bluegrass Tomorrow).

Develop and Execute Public Involvement Plan – One of the first tasks to be undertaken by the Access Management Implementation Task Force should be the development of a public involvement plan. A public involvement plan should be developed to ensure adequate involvement of stakeholders throughout the implementation process. States that have implemented access management programs generally feel that public involvement is crucial to the success of the program and that these efforts should begin early in the process. Public involvement activities might include some or all of the following: regional public information meetings or workshops, presentations to interest groups, statewide conferences, and a web site. Marketing materials such as PowerPoint presentations, brochures, and videos should be developed or acquired to assist with public involvement efforts.

It should be understood by KYTC decision makers and members of the task force that implementing an access management program could be a controversial undertaking. Marketing of the concept of access management will be an important component of public involvement activities. But, even with an effective marketing program, it is probably unrealistic to expect consensus from all stakeholders on all aspects of the program. Public involvement efforts should seek to fully inform and identify points of agreement as well as diverging opinions. The points of disagreement should be responded to in sufficient detail so that participants are made to feel that their opinions have been considered and dealt with fairly. An absence of active opposition rather than total acceptance is probably the most realistic goal of the public involvement process for implementing an access management program.

Finalize Access Spacing and Design Standards – This report contains a set of proposed standards for interchange spacing, signalized intersection spacing, unsignalized intersection spacing, median opening spacing, and corner clearance. Access design principles have also been discussed to a limited extent, and certain access design recommendations have been made. The standards and recommendations have resulted primarily from an assimilation of practices of other states with access management programs. The Access Management Implementation Task Force should review the proposed standards and either formally accept or adjust as may be deemed necessary for application in Kentucky. In addition, access design standards currently found in the Cabinet's Permits and Highway Design Guidance Manuals should be reviewed for their consistency with the requirements and objectives of the access management program, and appropriate revisions to these manuals should be made.

Initiate and Oversee Classification System Assignments – An access management classification system and a strategy for assigning a classification to all segments of the state-maintained highway system are included in this report. This procedure would involve the assignment of an initial classification using computer algorithms and information contained in the Cabinet's Highway Information System (HIS) database followed by GIS mapping and manual adjustments based on a consideration of factors not available in HIS. It is envisioned that the manual adjustments would be performed at the District Office level and reviewed by the Access Management Implementation Task Force for statewide consistency. The task force should initiate work on developing the computer programming necessary to perform the initial classification assignments and GIS mapping soon after formation. The task force will also have to formalize adjustment criteria and procedures for the manual review.

Develop Procedure for Classification Revisions – The parameters for the access management classification system recommended by this study were selected in order to produce a stable system that will seek to maintain the intended function of highways and streets over time. Frequent and/or piecemeal changes in classification have been strongly discouraged, as this practice would degrade the effectiveness of the access management system. Changes in a roadway's access management classification should be considered only in cases where the function of the roadway has been deemed to change. Primarily, this would occur as either a result of a systematic review of functional designations or as a result of new construction that might change the function of an individual route. However, there are likely to be cases where either the original classification assignment was not optimal or where significant changes in surrounding land use (or land use plans) warrant a classification change. It has been recommended that a multidisciplinary review committee make this determination. The Access Management Implementation Task Force should formalize criteria and develop procedures for classification reviews and revisions.

Develop Administrative Regulation – Formal implementation of the Kentucky Access Management Program will require legislative action in the form of an Administrative Regulation. The development and processing of the Administrative Regulation will be one of the most critical tasks required of the Access Management Implementation Task Force. As this can be a time-consuming task, requiring several months to a year or more to complete, work on drafting the regulation should begin as soon as possible (of course, certain key program decisions must be made before the regulation can be completed). An initial decision that will have to be made is whether the existing regulation dealing with highway access (603 KAR 5:120) should be modified or if an entirely new regulation should be developed.

Develop Procedures for Non-Conforming Access – The access management standards recommended here and ultimately put into effect by the Implementation Task Force are not retroactive. They will apply to requests for new access and to changes in existing access. Access that currently exists will frequently not conform to the new standards. Legal access that exists at the effective date of the new access management policy would be allowed to continue, and would not necessarily be impacted by the new standards. However, when changes are made in access configuration, land use, or intensity of development at properties served by existing access points, it would be highly desirable that the access be modified to be consistent with the new standards. In cases where full compliance is not practical because of development that has already occurred, efforts should be made to increase access spacing and improve access design. The Access Management Implementation Task Force should formalize criteria for non-conforming access and develop procedures for regulating change in use.

Develop Variance Process – Some flexibility is required when administering access management regulations. In conjunction with the standards that are adopted for access spacing and design, a variance or deviation process is needed to allow for lesser standards where special or unique conditions make application of the minimum standards inappropriate. The Access Management Implementation Task Force will need to formalize variance criteria and procedures. The challenge will be to provide flexibility while maintaining reasonable consistency. In order to improve consistency it is recommended that a multidisciplinary variance review committee be established to review requests for deviations that arise during transportation project development or access permitting. The benefit of a variance review committee is that it would provide a unified agency response that extends beyond an individual decision maker. This type of coordinated and consistent approach to deviation decisions should help counterbalance high-pressure lobbying tactics that may accompany a deviation request, and it should serve to protect the Cabinet in the event of a dispute.

In developing the variance process consideration should be given to establishing criteria for minor versus major deviations. The purpose would be to differentiate deviations that could have adverse impacts that would require analysis and consideration by the review committee from deviations that represent minor changes that could be addressed through basic documentation and streamlined decision making.

<u>Define Appeal Process</u> – An appeal is a request for reconsideration of a decision that has already been made. In the access permitting process an appeal may arise when a permit or variance request has been denied or if the Cabinet has established a permit condition that is not acceptable to the applicant. The Access Management Implementation Task Force will need to define and implement a formal appeal process. It is recommended that the Cabinet establish an administrative process that must occur before an applicant is allowed to resort to legal action. Consideration should be given to incorporating an administrative hearing overseen by an independent hearing officer as the final step of this process. The process should insure that the Cabinet has an avenue to district court and higher courts, should it lose an important decision at a lower level. The steps of the appeal process should be clearly stated in the access management regulation.

<u>Define Permitting Process</u> – It is primarily through access permitting and project development activities that access management standards are applied. Therefore, a well-conceived and executed permitting process is critical to the effectiveness of an access management program. While the Cabinet has an established and documented permitting process in place, it is evident that certain changes and enhancements to this process will be necessary so that the new access spacing and design standards can be applied to new development and re-development. The permitting process will also have to be expanded to include procedures for regulating change

in use and non-conforming access, requirements for traffic impact studies, and to include the new variance review and appeal processes. It is recommended that a flowchart be developed to identify the sequence of steps in the permitting process.

Define Organizational Structure and Roles/Responsibilities – Implementation of the Kentucky Access Management Program will require an expanded organizational structure, compared to the structure that currently exists for the Cabinet's access permitting function. The Access Management Implementation Task Force will need to determine the location(s) within the Cabinet where access management functions can be carried out most effectively. Key decisions include the organizational location and staff make-up of the Central Office access management unit, the level of authority of this unit, and the division of responsibilities between the Central Office and the District Offices. The roles and responsibilities of other supporting offices and functions within the Cabinet, particularly in the variance review and appeal processes will also have to be clearly defined.

Develop Access Management Manual – The definitive task and end product for the Access Management Implementation Task Force will be the development of a manual, or manuals, that provide documentation of the access management standards and procedures. It is envisioned that two versions of such a manual would be developed. A formal Access Management Guidance Manual, similar in format to the guidance manuals that have been developed for other Cabinet functions, will be needed. A decision to be made in this regard is whether the new Access Management Manual should encompass the Permits Guidance Manual that currently exists, or whether the Permits Manual should be revised and stand apart from the Access Management Guidance Manual. It would also be helpful to produce a manual that could be used to document Kentucky's program in a less formal and, perhaps, more informative manner. This version of the manual could be made available to persons outside the Cabinet that are involved in access issues or have an interest in the program. It should also be distributed to local planning agencies in Kentucky so that future subdivisions of land could be controlled in a manner that is consistent with the new standards and requirements.

Conduct Training – Implementation of the Kentucky Access Management Program will require new staff skills and new agency procedures. It would therefore be advisable to provide early and ongoing training for Cabinet staff. The Access Management Implementation Task Force should oversee the development and scheduling of workshops designed to provide both detailed technical instruction and executive overview type training. Initially, it is likely that training efforts would focus on Cabinet staff, but it would also be desirable to include consultants and local government staffs as the training efforts progress.

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APPENDIX A STATE REVIEW

A.1 States Bordering Kentucky

A.1.1 Illinois

The Illinois Department of Transportation (IDOT) Access to State Highways was placed into effect in May 1990 (1). The handbook provides some general guidelines and policy, with very little specific spacing or location requirements. IDOT establishes the primary purpose of their access management with the following access management goals:

- To provide for motorist and pedestrian safety through the orderly control of traffic movements on to and off state highways;
- To maintain the traffic carrying capacity of State highways, thus protecting the public interest in these facilities; and
- To assure uniform standards and practices for access throughout the state (1).

A number of general access requirements are included in the handbook including the permit process, construction methods, and geometric standards. An access permit is required for every access point and should include the location and description of the proposed work and be accompanied by plans and/or drawings.

The handbook explains that a number of local regulations must also be considered when granting access to roadways. It is the responsibility of applicants to comply with local land use and zoning plans, building codes, setback regulations, minimum lot sizes, density of buildings, provisions for adequate parking, historic preservation requirements, and other ordinances and regulations. Often times a surety bond is required in order to protect the department against the cost of completing or removing construction or correcting deficiencies.

There are also a number of entrance design requirements in the handbook that outline the requirements for entrances in terms of grades, sidewalk interruption, curbing, dimensions/geometry, flare, and angularity of the entrance.

A.1.2 Indiana

The Indiana Department of Transportation (INDOT) has a driveway permit manual, which sets forth a series of guidelines relating to state and federal roadways, and how these roads should be regulated (2). INDOT specifically notes that the manual is only to be used for reference and every case is handled individually, requiring a degree of engineering judgment.

The manual deals only with driveways, but addresses the issue thoroughly. There are four primary driveway types that are divided into seven approach classes differentiated by land use, urban/rural location, and driveway characteristics (material used for driveway). Driveway permits are separated into four types by INDOT and are as follows.

(1) Commercial Major Driveway Permit: This type of approach connects the highway to private property used for commercial purposes or to a public property, which attracts enough traffic to require auxiliary lane(s) (left or right turn lanes). INDOT has a process for determining when such lanes are necessary. The location for this type can be in either an urban or rural area.

(2) Commercial Minor Driveway Permit: This type of approach connects the highway to private property used for commercial purposes, or to a public property, and which does not attract sufficient traffic to warrant an auxiliary lane(s). The location for this type can be in either an urban or a rural area.

(3) Commercial Sub-Minor Driveway Permit: This type of approach connects the highway to private property used for commercial purposes, and which does not attract more than 25 vehicles per day. The location of this type can be either in an urban or rural area.

(4) Private Driveway Permit: This type of access connects the highway to private property having a residence, barn or private garage, used by the owner or occupant of the premises, guests, and necessary service vehicles. The driveway can be in either an urban or a rural area.

Another guideline outlined in the manual emphasizes the need for adequate sight distance when determining the placement of driveways and stresses that inadequate sight distance can be a reason for denial of a permit.

A.1.3 Missouri

Missouri implemented a new access management plan effective as of January 2003 (3). A roadway classification system was first established in order to implement the access management plan. It was based on the existing Missouri DOT functional classification system. The system identifies the present and future functional role of the roadway using ten classes. The classifications include five primary categories, each with a rural or urban element. The next step was to develop standards for intersections and interchanges, driveways, and a number of other related issues. These standards include freeway and expressway transition standards, spacing for public road intersections, spacing of traffic signals, driveway spacing and density, sight distance minimums, and driveway characteristics. The standards include spacing distances, as well as construction specifications such as the materials to be used for construction. The access management strategies are applied to all new construction areas, and on existing roadways where possible (during construction or "retrofit projects"), while considering economic, physical, and other constraints.

In Missouri, the planning and traffic staff of individual districts determines the urban and rural boundary points along each route for the implementation of access management. It is recommended that this task be completed with consultation from appropriate Metropolitan Planning Organizations (MPO), regional planning, and local government representatives. It is also noted in the plan that separation of urban and rural designations must occur at a readily identifiable physical feature, such as a bridge, creek, river, or public road intersection. In order to avoid numerous designation transitions, urban sections must be at least 0.5 miles in length. It is also noted that these designations are subject to change over time, and should be reviewed every two years. As a basis for designation the U.S. Census Urbanized Area Guidelines can be used to identify future urban areas.

A.1.4 Ohio

Ohio implemented an access management program in December 2001 (4). Their system is based on a highway classification scheme that classifies all roads into five categories. Category I includes high volume, high speed, and low accessibility roads whereas Category V includes low volume, low speed, and high accessibility roads.

Each access category is described by a chart with the various design and specification features of the roads. The access features included are permitted movements, spacing, traffic control, traffic movement, right turn lanes, left turn lanes, right acceleration lanes, and left acceleration lanes. These access features are further described by the presence of interchanges or intersections and by the volume generated at the access points. Within each access category a minimum driveway spacing table is included that regulates the minimum spacing that is required between driveways for that category based on a posted speed.

Additionally, "a Traffic Impact Study (TIS) is required for any proposed access to development or land use, which will generate or has the potential to generate traffic volumes equal to or exceeding 100-vehicle trip ends during the peak hour of the development (4)." The traffic impact study is used when determining spacing requirements and classification categories. Traffic studies may be required for specific times during the week or on weekends when the development is expected to attract most of its traffic. Additionally, traffic impact studies may be required if the proposed access is located within a safety problem area, high crash area, or a congested traffic area.

The Ohio Department of Transportation (ODOT) uses an access permit system in which the department reviews all applications, some in more detail than others depending on the request. Furthermore, problems associated with the construction of a proposed access are taken into consideration. Additionally, an appeals process is set forth for applicants seeking a variance from the standards prescribed in the *State Highway Access Management Manual (4)*. Some of the considerations for granting an exemption include whether the variance:

- meets minimum acceptable ODOT engineering standards including geometric design, operation, and safety elements and if the variance is shown to be beneficial to the traveling public;
- is not detrimental to the public health, safety, and welfare;
- must be shown to be beneficial to both the planned or intended operation of the state highway; and
- is shown to be in conformance with an access management plan, if applicable, that has been accepted by ODOT District and Central Office (4).

A.1.5 Tennessee

The access management plan currently in place in Tennessee pertains only to driveways that intersect state highways (5). Tennessee DOT recognizes the fact that the regulations were established some time ago and they are currently revising them. The current rules concerning construction of driveways on state highway right-of-way apply to the number and arrangement of driveways, sight distance, parking, driveway geometry, curbs, and signing. The rules provide the required widths of driveways, entrance angles, surfacing materials, and number of driveways allowed for the frontage involved.

The manual outlines a number of different situations for urban and rural areas. Residential and commercial driveways are discussed and diagrams are provided to show location, geometric design, and other characteristics such as curb and drainage design.

In addition to the driveway issues, right-of-way encroachment is outlined as it pertains to parking and a buffer area. The buffer area is defined as "the border area along the frontage between the traveled way and the right-of-way line and within the frontage boundary lines areas (5)." The guidelines state that the buffer area must be provided to ensure proper sight distance. Where possible, driveways shall be located to allow for maximum sight distance along the highway and must be located so that entering and exiting vehicles have adequate space to complete turning movements. The guidelines also state that parking should be kept off right of way, to prevent storage of vehicles or the backing up of traffic on the roadway.

A.1.6 Virginia

Virginia has an access management program that is derived from two manuals: *Minimum Standards of Entrances to State Highways* and a *Land Development Manual* (6, 7). The Land Development Manual is considered to be a supplement for use with the Standards of Entrances manual; however, both documents provide only general information in regard to access management. The Minimum Standard of Entrances focuses primarily on geometric and construction issues related to driveways and entrances, whereas the Land Development Manual promotes increased safety through access management, with general guidelines and references to other materials such as the Green Book (8).

The Land Development Manual states that "currently, VDOT does not have any regulatory authority to control access onto non-limited access facilities other than the regulations found in the Standards Manual." Furthermore, it is acknowledged that an access point may be denied legally, but that access to the property must be provided. In order to deny an access point, a decision must be made based on principles that are "reasonable and necessary to the public interest." Permits are granted by engineers for those entrances that are necessary to serve a site, while giving attention to the impact the entrance will have on the safety and capacity of the roadway. With this in mind, the Standards do not restrict the number of entrances for a particular site.

Neither document differentiates between roadway types or classifications in respect to volume or any other characteristics. Intersection spacing and location is referred to briefly. General guidance is suggested by using AASHTO specifications for corner clearance, driveway separation, and cross street separation, but this guidance does not constitute standards or requirements (8). Other than sight distance, no requirements are given for spacing or location of entrances. The manual and the standards, however, iterate that sight distance must be met at entrances in order to be permitted. The sight distances are based on those provided in the Green Book (8). Exceptions to the sight distance requirements are made only by the Chief District Engineer, and are to be based on a traffic engineering investigation.

Overall, no specific guidelines are provided for access management in either manual. VDOT only requires that decisions on location, spacing, and design be made to minimize disruption and uphold safety. References to other sources, such as the Green Book, and general statements are provided for guidance in decision-making but not as regulation.

A.1.7 West Virginia

West Virginia was in the process of adopting a set of driveway management guidelines as of January 2003. Guidelines are detailed in the "Manual on Rules and Regulations for Constructing Driveways on State Right-of-Ways (9)." This manual defines the appropriate location, construction, and design of all driveways in West Virginia.

The number of driveways along with their location is the primary purpose of the regulations. A number of restrictions regarding the location of driveways given in the manual are listed below (9):

- Vehicles entering or leaving driveway locations do not interfere with roadway traffic movement;
- When feasible, driveways should not be located in sharp curves or on steep grades;
- Driveways should be located where the optimum sight distance is available;
- Driveways should not be located in the functional area of intersections radii;
- Driveways should be located where they will not interfere with devices that regulate traffic operations (9).

The West Virginia manual also includes specific information pertaining to driveway geometry (grades, intersection angles, widths), surfaces, and other associated aspects (signs, mailboxes, fences, drainage). With the exception of driveway types (commercial, residential, farm, industrial) no other classification system is cited in regard to categorizing entrances. However, a number of illustrations of entrances are included in the manual to provide examples of proper entrance design.

A.2 States Bordering Kentucky

A.2.1 Colorado

The Colorado State Highway Access Code, enacted in August of 1998, requires all proposed plats seeking access to state highways to comply with state access requirements (10). The original code was adopted in 1981, and was revised in 1982, 1984, 1985, 1996, and 1997. Colorado Department of Transportation (CDOT) controls 9,200 miles of highway (11).

Roadways are classified into eight classes. Five broader classes encompass these roadways: Interstates and Freeways, Expressways, Rural Highways (two categories), Non-Rural Highways (three categories), and Frontage Roads (both urban and rural). The basis for classification is generally roadway function, traffic volume, speed, intended accessibility, and the availability of local road access.

The code establishes specific warrants for each access design element and criteria for the location of access and traffic signals. Furthermore, the width and radius of the access is defined dependent on vehicle type. Information regarding the use of acceleration lanes is also detailed. One key difference between Colorado and other states that should be noted is the use of a 4.25 ft height of object for sight distances, which is substantially greater then the typical 2 ft height recommended by the Green Book (8). CDOT often acquires access deeds (purchase the rights) to achieve full access control of private property along high-priority corridors. The code prohibits direct highway access from subdivisions and requires subdivisions to have internal, local, and collector street systems. All proposed plats abutting state highways are reviewed by the CDOT for conformance with the state highway access code. An appeal process is also outlined in the Colorado code. A 3-member panel, selected by the Executive Director of the Colorado DOT, reviews all appeals. The panel consists of two DOT staff members and one member not employed by the DOT. Colorado law allows local governments to adopt the state standards or establish their own ordinance.

A.2.2 Florida

Florida adopted an access management and classification system defined by Administrative Rules 14-96 and 14-97 of the Florida Access Code. Administrative rule 14-96 defines the administrative process, permit requirements, fee structure, driveway enclosures, and other administrative procedures. Administrative Rule 14-97 outlines the access management classification system and standards for the state highway system (12). Florida controls 11,803 miles of roadway utilizing a decentralized access management program that was enacted by the legislature in 1988. The central office coordinates and trains employees, while individual districts are responsible for permitting.

The use of medians plays an important role in the classification and design of Florida's roadways. Florida Department of Transportation (FDOT) passed a Multilane Facilities Median Policy in 1993, which specifies that all highways with a design speed over 40 mph shall have restrictive (non-traversable) medians. Additionally, the following design standards for medians are outlined in regard to achieving access management:

- Adopting a standard taper length of 15m for left-turn and right-turn bays.
- Minimum left-turn queue storage of 2 cars at rural median openings, 4 cars in urban areas.
- New and revised median opening designs. The median openings are to have left-turn deceleration and storage bays.
- Changes in unsignalized openings are made as a part of resurfacing projects. New unsignalized median openings are designed and constructed as directional openings – mostly left-turn/u-turn only (12).

Florida utilizes a classification system with seven classes. State highways in Florida are assigned to an access management class following the approach outlined here:

- Define Segments: Length and termini are defined by area type boundaries by the department and the Metropolitan Planning Organization for urbanized areas and by the Department and appropriate local governments in urban areas with population between 5,000 and 50,000. Physical characteristics and boundaries will be used rather than imaginary lines.
- Assignment of an access classification to all state highway system segments: All limited access facilities shall be assigned to Access Management Class 1. All controlled access facilities shall be assigned to Access Management Class 2 through 7.

- FDOT shall make an initial access management classification assignment to all segments of the state highway system.
- Interchange and Connection Review Process: Interchanges are based on spacing standards and on the area type in which the segment is located.
- Permit applications for new or modified connections to controlled access facilities follow Administrative Rule 14-96, Florida Access Code (12).

Each class with their applicable standards is listed in Table A-1.

Table A-1 Florida DOT Access Management Standards (Rule 14-97)

Access Class	Area Type	Description	Interchange Spacing
1	Area Type 1	Segment Location CBD & CBD Fringe for cities in urbanized areas	1 mile
	Area Type 2	Existing Urbanized Areas Other than Area Type 1	2 miles
	Area Type 3	Transitioning Urbanized Areas and Urban Areas other than Area Type 1 or 2	3 miles
	Area Type 4	Rural Areas	6 miles

Access Class	Medians	Connection Spacing (Feet)		Median Opening Spacing		Signal Spacing (feet)
		>45mph	<45mph	Directional	Full	
2	Restrictive w/ Service Roads	1,320	660	1,320	2,640	2,640
3	Restrictive	660	440	1,320	2,640	2,640
4	Non-Restrictive	660	440			2,640
5	Restrictive	440	245	660	2,640/ 1,320	2,640/ 1,320
6	Non-Restrictive	440	245			1,320
7	Both Median Types	125		330	660	1,320

A.2.3 Iowa

Iowa does not have a standard "classification" system. However, they define various types and groupings of roadways. In addition to the highway designations, entrances are also divided into separate categories as follows (13):

Type "A" entrance: An entrance developed to carry sporadic or continuous heavy concentrations of traffic. An entrance of this type would normally consist of multiple approach lanes and may incorporate a median. Possible examples: race tracks, large industrial plants, shopping centers, subdivisions, or amusement parks.

Type "B" entrance: An entrance developed to serve moderate traffic volumes. An entrance of this type would normally consist of one inbound and one outbound traffic lane. Possible examples: service stations, small businesses, drive-in banks, or light industrial plants.

Type "C" entrance: An entrance developed to serve light traffic volumes. The entrance would not normally accommodate simultaneous inbound and outbound vehicles. Possible examples: residential, farm or field entrances.

Additionally, the manual distinguishes between rural and urban designed areas. A Rural-design area is an area in which the predominant cross section accommodates surface drainage from the roadway and adjacent terrain via an open ditch. An Urban-design area is a built-up or fringe area in which the predominant cross section accommodates roadway surface drainage by means of a curbed roadway.

In places where access rights have not been acquired an entrance permit must be obtained in order to modify or construct an access point. The manual contains the procedures for completing an entrance permit in addition to the maintenance and primary road extension policies. The handbook further develops standards on entrances by placing regulations on radius or flared returns, entrance angles, and slope and cross sections of each entrance type. The policy on Location of Predetermined Access Locations has been defined in the following Table A- 2.

Table A- 2 Spacing Requirements – Iowa Department of Transportation

TYPE OF HIGHWAY	Urban/Rural	Minimum Requirements	Desired Requirements
Priority I	N/A	Access is allowed only at interchange locations	N/A
Priority II	N/A	800 meters	1,600 meters
Priority III	Rural	300 meters	400 meters
	Urban	200 meters	N/A
Priority IV	Rural	200 meters	N/A
	Urban	100 meters	N/A

There is also a policy defined on special access connections where access rights have been previously acquired. A list of the various requirements of a special access connection is also provided. These include:

- Whenever possible, a special access connection should be established as a joint access location to serve more than one property ownership.
- A special access connection is a special permit for access and is not a permanent right of access to the highway.
- The property owner shall be responsible for all costs incurred for the construction of the approved connection, including any required drainage structure.
- The department in the county recorder's office shall record a special access connection and a restriction will be placed upon the property. All provisions of the special access connection shall be binding on successors or assignee of the applicant property owner.
- Special access connections shall be constructed in compliance with all relevant rules.
- Spacing for special access connections shall conform to rules and shall be maintained on both sides of the highway (13).

A.2.4 Kansas

Kansas Department of Transportation (KDOT) access management is set forth in a "Corridor Management Policy" handbook consisting of four sections: General Policy, Typical Access

Layouts, Access Criteria, and District Corridor Management Plans (14). The policy was adopted in July 1997.

The General Policy Section is sub-divided into four subcategories, which discuss policy application, procedures, permit, and design considerations respectively (14). In this section, the purpose of corridor management is reiterated along with where the authority lies regarding access management. It also implements a classification system consisting of 5 classes. KDOT classifies state roadways according to their level of importance to the highway system. The classifications are designated as A, B, C, D, and E routes, where A Routes are those of highest access control.

Design and geometric guidelines are outlined for approaches including, taper, driveway angle, edge clearances, and grade. Additionally, medians, islands, sight distances, and setbacks are discussed in regard to design and access management. Another feature of the Kansas plan enables the KDOT to use state funding to improve local roadways that are within 0.5 miles of a state highway, when the improvements will benefit the state highway. Additionally, there is an overlay procedure that allows for higher classification of "critical" sections of roadways, so that stricter standards may be used. It is also noted that KDOT has not differentiated access standards in regard to rural and urban designations.

A.2.5 Maine

The access management plan for Maine is divided into two parts: Highway Driveway Rules and Entrance Rules (15). It includes access management rules and corridor planning, as well as preservation initiatives. Maine Department of Transportation (MDOT) requires that a permit be issued by MDOT prior to the beginning of construction, alteration, or removal of any portion of state access.

Driveways and Entrances onto state and state aid highways that are located outside urban compact areas must comply with a number of basic safety standards. A minimum allowable sight distance is required for Driveways and Entrances, as listed in Table A- 3. However, MDOT may require up to 50% greater sight distances when at least 30% of the traffic using the driveway will be larger vehicles.

Table A- 3 Sight Distance for Driveways and Entrances – Maine Department of Transportation

Posted Speed (MPH)	Sight Distance (Ft) (For Driveways and Entrances)	Sight Distance Larger Vehicles (For Entrances)
20	155	230
25	200	300
30	250	375
35	305	455
40	360	540
45	425	635
50	495	740
55	570	855
60	645	965

Additionally, the driveway width within the highway right-of-way must be between 12 and 22 ft, while the width of a two-way entrance within the highway right-of-way must be between 30 and 42 ft. The following additional geometric guidelines are outlined in the manual:

- "The minimum corner clearance for driveways is 75 ft and for entrances onto major Collectors or Non-compact Arterials is 100 ft, for unsignalized intersections. For signalized intersections, the corner clearance is 125 ft for both driveways and entrances.
- All driveways and entrances should have a turnaround area at least 8 feet wide by 15 ft long.
- The minimum radius on the edge of a driveway or entrance, if any, must be 10 ft (15)."

Furthermore, entrances onto Major Collectors and Arterials must comply with geometric and construction standards for paving, corner clearance, on-street parking, radius of edges, throat length, one-way entrance requirements, entrance separator strips, and double frontage lots. Similarly there are guidelines for Retrograde Arterials and Mobility Arterials. A Mobility Arterial is a non-compact arterial (one outside of urban compact areas) with the following characteristics:

- Part of an arterial corridor between urban compact areas or service centers that carries at least 5,000 vehicles per day for at least 50% of its length, with a posted speed limit of 40 mph or less. Or,
- Is part of a Retrograde Arterial Corridor located between Mobility Arterials.

A Retrograde Arterial is a Mobility Corridor where the access related crash-per-mile rate exceeds the 1999 statewide average for arterials with the same posted speed. The guidelines for these are as follows:

- "Mobility Arterial standards are defined for mobility sight distance, spacing between driveways or entrances, mobility arterial corner clearance, controlled access off-ramp setback and shared driveways.
- Mobility standards are also defined for number of entrances, traffic signal restrictions (like signal spacing) and shared entrances.
- Driveways onto Retrograde Arterials may be required to create or expand paved shoulders for a length not to exceed 75' on either side of the proposed driveway.
- Retrograde Arterial standards for entrances are defined for paved shoulders and mobility enhancement measures and MDOT may require a traffic impact study in accordance with 17-229, Maine Administrative Rules (15)."

A.2.6 Minnesota

The guidelines set forth by Minnesota define a system of access guidelines and categories for the state trunk highways with associated guidelines for the spacing and design of public and private access. Criteria are established for intersection spacing, signal spacing, and driveway spacing. It is noted that the information pertaining to spacing is not design standards, but only guidelines to be used when feasible (16).

The key concepts underlying the roadway classification categories are roadway functional class and the strategic importance of certain highways such as Interregional or Regional Corridors. Classes are further delineated based on different community contexts (nature of existing and proposed development), network connectivity, and mobility (maintain speed) on Interregional Corridors. The Access Category System includes seven primary categories and five subcategories. The primary categories are based on the functional classification of the roadway and its strategic importance within the statewide highway system. The subcategories are used to address specific facility types and differing land use patterns that surround the primary roadway. Assignment of roadways to categories is a combined effort by the MNDOT, local government units, MPOs, and regional development commissions.

Guidelines have been developed for the recommended spacing of public intersections, as well as private driveways and entrances. Guidelines have also been developed for recommended spacing and timing of traffic signals on the higher category roadways. The Gap Analysis Procedure is also discussed when considering the intersection of a secondary intervening intersection or private entrance. In order to identify potential high-risk areas where additional access is not advised, a simplified approach to gap analysis has been developed for application to unsignalized corridors.

There are also exception and deviation provisions outlined by MNDOT. The Exception Provision is intended to address lower volume access requests, while the Deviation Provision is intended for higher volume, more complex access requests that may pose greater potential impact on the safety and operations of the highway.

Exception and deviation requirements have been divided into twenty-one different category types and five access types. There are two primary access types: private entrances and public streets. Private entrances are divided into three types: residential and agricultural access, low volume, and high volume. Public entrances are divided into low and high volume. The exception process defines an additional level of criteria for the permitting process that promotes responsible land use and access management. The deviation process is similar to the exception process and applies to access locations where safety and operational concerns should be more thoroughly explored. Therefore, approval of deviations involves some level of planning for future operations along the affected roadways, including the existing and future land use and circulation of the surrounding area.

A.2.7 Montana

Montana is in the process of implementing an access management plan. The material completed thus far offers the background, objectives, and an approach to access management for the state (17). The background briefly summarizes the previous rules/regulations used with regard to access management. The objectives set forth the need and desire to change the current situation and what their primary goals are for access management in Montana. The approach discusses how the state plans to achieve its objectives.

Additional information, referred to as Organizational Readiness, provides an overall synopsis on how ready and able the Montana Department of Transportation (MDT) is to implement an access management program. Some MDT employees have expressed concerns and particular obstacles they feel they will face in trying to implement such a plan. Specifically, concerns were discussed regarding the topics of access control resolutions, driveway approach standards and permits, management, and organization.

The following elements were identified as components the of Montana's Implementation Plan:

- Establishing the access classification system
- Developing and adopting new entrance standards
- Implementing access control resolution projects to purchase access rights
- Establishing procedures for working with other jurisdictions
- Incorporating access management-related design criteria into roadway design manual.

A.2.8 New Jersey

The New Jersey Highway Access Management Code (1998) requires consistency of local master plans and circulation plans with state access management requirements, and prohibits access when the subdivision of property on a state highway is not consistent with state access standards (18). It provides opportunities for municipalities to adopt access management plans and submit them for review and adoption by the New Jersey Department of Transportation (NJDOT). NJDOT has readopted the State Highway Access Management Code with amendments made to the 1992 code.

The Access Management Code sets standards for driveways and other means of physical access to and from state highways, and establishes an access level for each segment of state highway. The access levels set in the regulations help to preserve the capacity of the state highway system and mobility in highway transportation corridors (19). NJDOT defines seven access levels between public highways and activity centers, where the type of access permitted defines the various levels. This type of system is in contrast to those used by states such as Florida and Colorado, which assign a classification then identify the allowable access. The highest level of management, Level 1, includes freeways, while Level 7 encompasses frontage roads and local roadways. Rather than associate the levels with a specific functional class, a more refined system was developed utilizing the functional class, highway design features (such as a median), and the degree of urbanization (urban, suburban, rural).

A.2.9 Oregon

The Oregon Department of Transportation (ODOT) controls 6,784 miles of highways, excluding freeway-type roadways. Of these 6,152 miles are rural and 636 are suburban/urban. ODOT access management is a decentralized program that includes 5 regional offices and 27 district offices. The central office is responsible for training and coordination, but the primary responsibility for permit approval is at the district office (11).

Oregon's access management manual consists of three volumes: Approach Application and Permit Process, Analytical and Technical Information, and Central Highway Approach/Maintenance Permits System (CHAMPS). Access management is imbedded into administrative rules, which were adopted in 2000. This adoption followed a general revision of the access management program that began in 1995. The revision activities included: draft changes in the statute, new and revised administrative rules, access classification criteria, spacing standards, access management policies, changes to the application and permit process, revised design standards, technical papers on access topics and techniques (20), and training materials and courses.

ODOT uses corridor planning as a mechanism for coordinating state and local transportation planning and access management objectives (21). Corridor plans are prepared by ODOT for long-range management of transportation facilities. Roads are classified as either Rural or Urban and further as a Special Transportation Area, Urban Business area, or Commercial Center. The access management spacing standards for both private and public approaches on statewide highways, regional highways and district highways are defined. Additionally, minor deviation limits for statewide, regional and district highways, as well as, spacing standards applicable to freeway interchanges with multi-lane crossroads are specified. One omission of the access program is the identification of medians and median openings (11).

A.2.10 South Dakota

The South Dakota Access Management criteria include standards for traffic signal spacing, median opening spacing, unsignalized access spacing, and access density for seven access classifications of highway (22). The classifications are set forth and updated periodically by the DOT. An access manual provides an overview of the benefits of having an access management program in place and discusses the main principles of the South Dakota Department of Transportation (SDDOT) Access Management Policy.

The manual also outlines the permit procedure that all new access onto state highways must be granted through. Another topic of discussion involves SDDOT owned access rights. In cases where the SDDOT has purchased the access rights adjacent to high-volume roadways, no new permits should be granted unless the Transportation Commission approves.

SDDOT utilizes the following techniques for access management:

- Access consolidation
- Traffic signal spacing requirements
- Medians and median openings
- Unsignalized access spacing (Driveways and Intersections)
- Corner clearance requirements
- Continuous Two-Way Left-Turn Lane
- Install barriers to prevent uncontrolled access
- Install driveway channelizing islands
- Auxiliary Lanes.

In addition South Dakota utilizes a number of other techniques that focus on reducing the effects of turning vehicles that are either entering or exiting the through travel lanes. These methods are discussed in more detail here.

Convert access to right-in/right-out - Restricting movements of an access point to right-in and right-out must be accompanied by an alternative location for performing left turns. The best locations for imposing restricted movements are driveways that don't meet current access criteria. Conversion of a driveway to right-in/right-out movements only is considered to be within SDDOT's authority for maintaining the highway system. No landowner compensation is required unless additional right-of-way is needed.

TWLTL - A two-way left-turn lane (TWLTL) removes left-turning vehicles from the through lanes and stores those vehicles in a median area until an acceptable gap in opposing traffic appears. These lanes should be considered on roadways where numerous, closely spaced, low-volume access connections already exist. Projected major road volumes should be up to 24,000 vehicles per day and/or access density should be at least 60 driveways and/or local streets per mile. Operating speeds for roadways being considered for TWLTL should be between approximately 25 and 45 mph. Two moderate to high volume access points should not be located in close proximity to each other. The preferred center turn lane width in South Dakota is typically 12 feet, but can range from 11 to 16 feet. The width should not exceed 16 feet, thereby precluding the possibility of side-by-side left turns.

Provide separate left-turn entrances and exits - Replaces either one or two full-movement access connections with two limited-turn connections to separate the left-turn movements to and from the site. This is applicable on divided roadways at regional shopping centers or major traffic generators with significant left-turn volumes and sufficient frontage to provide for adequate separation distances between the two connections. It is also applicable where there is insufficient storage distance for the turning movements at the two or more existing full-movement driveways.

A.2.11 Texas

The Texas Department of Transportation (TxDOT), along with the Texas Transportation Institute (TTI), has completed extensive research and development work in access management. The result of this work is a proposed access management plan discussed here (23).

As with many states, the roadway classification system is the basis for their program. The classes range from AC 1 to AC 7, where AC 1 includes multilane, non-traversable median roadways and AC 7 is made up of lower class two lane roadways. The classes are based on the functional classification system, however, it is noted that a separate access classification system is necessary to apply the appropriate access management treatments. Therefore, the classification system was designed to reflect the following components- roadway purpose, land use, design features (median, lanes), location (urban/rural), and safety (crash rates and type). Additionally, it is recommended that the district engineers be responsible for this classification. It is also noted that they may appoint a committee to classify roadways that could include the following:

- Local district staff members,
- Local area engineer
- Local MPO
- Local city/county representative; and
- Statewide access management coordinator (for review purposes).

"The following techniques were determined to be applicable to Texas and have been evaluated in further detail for inclusion in the access management program.

- Signalized intersection access spacing;
- Unsignalized intersection access spacing;
- Signalized intersection corner clearance criteria;
- Unsignalized intersection corner clearance criteria;
- Directional median spacing criteria;
- Full median spacing criteria;
- Auxiliary lanes (including right-turn and left-turn lane criteria);
- Alternatives for left-turn treatments (U-turn and jughandle);
- Access separation at interchanges;
- Arterial frontage roads;
- Freeway frontage roads;
- Site development traffic impact analysis guidelines (23)."

TxDOT reports that future work for development of their access management handbook include the appointment of a DOT supervisor, designation of roadways to their respective classes, and final development of guidelines dictating the need for a Traffic Impact Analysis (TIA). Additionally, details of permitting, implementation, and handbook development will be completed with future research.

A.2.12 Washington

The Washington Department of Transportation's (WDOT) stated goal of access control is to preserve the safety and efficiency of specific highways and to preserve the public investment

(24). Access management standards such as spacing are determined based on a number of criteria including the functional class, future and present land use, environment and economic considerations, and highway design and operation.

Roadways under access control are termed as limited access or access controlled highways and further as full, partial, or modified access control. Full access control criteria may be applied to Interstates, Principal Arterials, Minor Arterials, and Collectors. Full access control highways are designed to prevent disruption by providing access connections through interchanges at selected public roads and to rest areas, and by prohibiting all crossings and private connections at grade. Partial access control criteria can be applied to Principal Arterials, Minor Arterials and Collectors. This level of control may be applied to a new alignment or an existing one. It is intended to provide protection from traffic interference and protect the highway from future strip-type development. Three approach types may be permitted for direct access to the highway - residential, farm and special use (like utility). Modified access control criteria are applied on existing highways, based on design analysis and exceptions. It is intended to prevent deterioration in safety and operational characteristics of existing highways associated with strip development by limiting the number and location of access points on highway. Five approach types are permitted - residential, farm, approaches to serve more than one owner and/or utility, and single or double commercial approaches.

Frontage roads are also discussed and are provided in conjunction with limited access highways in order to control access to through lanes, provide access to abutting land ownership, or to restore continuity of the local street or road system. Additionally, interstates and interchanges are examined in detail. The stated purpose of an interchange is to eliminate conflicts caused by vehicle crossings and to minimize conflicting left-turn movements. They are provided on all Interstate highways, freeways, other routes on which full access control is required, and other locations where traffic cannot be controlled safely and efficiently by intersections at grade. A great deal of detail is included in regard to interchange design, weaving, and ramp design.

A.2.13 Wisconsin

The Wisconsin DOT has statutory authority to regulate access to the state highway system by monitoring the sub-division of lands that abut the highway (25). Regulations are designed to limit the number of connections along a state highway. This is accomplished by requiring that local traffic generated in subdivisions must be served by an internal street system. In addition, new subdivisions must be designed so that individual parcels do not require direct highway access.

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APPENDIX B STATE CLASSIFICATION SYSTEMS

B.1 Generalized Description

B.1.1 Colorado

Colorado uses eight classes to separate their roadways. There are five broader classes that encompass Colorado roadways: Interstates and Freeways, Expressways, Rural Highways (2 categories), Non-Rural Highways (three categories), and Frontage Roads for both urban and rural areas. The basis for classifications is generally optimum speed, traffic volumes, and intended accessibility (1, 2). The following Table B-1 shows this classification.

Table B-1 Colorado Classification System

Type	Speed	Rural / Urban	Volume	Type of Travel/Roadways
F-W (Interstate)	High	R/U	High	Interstate/intercity
E-X (Expressway)	High	R/U	High	Intra-city/intercity
R-A (Regional Highway)	Med-High	R	High	Intercity and Regional
R-B (Rural Highway)	Med-High	R	Low	Local rural travel
NR-A (Non-rural Highway)	Med-High	U	High	Interregional, intra-regional, intercity, intracity
NR-B (Non-rural Highway)	Moderate	U	High	Sections of regional highway (that pass through rural communities)
NR-C (Non-rural Highway)	Moderate	U	Low	Extensive roadside development ("downtown" areas)

B.1.2 Ohio

Ohio classifies all roads into five categories. Category I includes high volume, high speed and low accessibility roads, while Category V includes low volume, low speeds and high accessibility. Initial assignment of access categories is determined in coordination with local authorities, the public, and the highway department. Decisions are based on the following information (3):

- “Current functional class;
- Existing and projected traffic volumes and vehicle mix;
- Existing and projected capacity and level of service;
- A survey of existing character of land and proposed or anticipated land use adjacent to the highway, whether developed or undeveloped, and the type of development;

- A survey of physical features of the roadway;
- Adopted local transportation plans and needs;
- Adopted local land use and zoning plans, subdivision/commercial/ industrial regulations;
- Availability and reasonableness of alternative access to public street and road system rather than to the state highway; and
- Posted or operating speed."

Table B-2 summarizes the descriptions used for the Ohio classification scheme.

Table B-2 Ohio Classification System

Category	Traffic Function
I	High speed, high volume, long distance through traffic for interstate, intrastate, intercity travel; all Interstate and Freeway type facilities are included in this category.
II	Relatively high speed, high volume, long distance through traffic for interstate, interregional, intercity, and some intra-city travel. Typically includes Expressways and facilities in an early stage of design, intended to become Category I as funding and priorities allow.
III	Moderate to high speeds, volumes, and distances for interregional, intercity and intra-city travel. Typically includes rural arterials, high-speed urban arterials, and some urban collectors.
IV	Balanced service for access and mobility at moderate to high speeds and volumes in rural areas for moderate to short distances and low to moderate speeds and volumes in urban areas providing intercity, intra-city, and intra-community travel. Typically includes rural collectors, low to moderate speed urban arterials, and most urban collectors.
V	Low volume rural highways, rural and urban streets and roads. Typically includes routes providing local land access, including frontage roads.

B.2 Functional Classification System

B.2.1 Minnesota

The key concepts underlying the roadway classification are functional class and the strategic importance of the highways. The idea of strategic importance of roadways is used for freeways and principal arterials, which are categorized as Interregional or Regional Corridors (4). The Access Category System includes seven primary categories and several subcategories. The primary categories are based on the functional classification of the roadway and its strategic importance within the statewide highway system. The freeways and principal arterials are divided into 4 categories and the remaining 3 are for minor arterials, collectors, and local roads. The subcategories are used to address specific facility types and differing land use patterns that surround the primary roadway. Table B-3 provides a summary of the access categories and their subdivisions.

Table B-3 Minnesota Access Management

Category	Area Type	Functional Classification	Statewide Strategic Importance	Typical Posted Speed
1	High Priority Interregional Corridors			
1F	All areas	Interstate Highways	High Priority Interregional corridor	55–75 mph
1A-F	All areas	Principal Arterials	High Priority Interregional corridor	55–65 mph
1A	All areas	Principal Arterials	High Priority Interregional corridor	55–65 mph
2	Medium Priority Interregional Corridors			
2A-F	All areas	Principal Arterials	Medium Priority Interregional corridor	55–65 mph
2A	Rural/Exurban/ Bypass	Principal Arterials	Medium Priority Interregional corridor	55–65 mph
2B	Urban/Urbanizing	Principal Arterials	Medium Priority Interregional corridor	40–55 mph
2C	Urban Core	Principal Arterials	Medium Priority Interregional corridor	30–40 mph
3	High Priority Regional Corridors			
3A-F	All areas	Principal Arterials	High Priority Interregional corridor	55–65 mph
3A	Rural/Exurban/ Bypass	Principal/Minor Arterials	High Priority Interregional corridor	45–65 mph
3B	Urban/Urbanizing	Principal/Minor Arterials	High Priority Interregional corridor	40–45 mph
3C	Urban Core	Principal/Minor Arterials	High Priority Interregional corridor	30–40 mph
4	Principal Arterials in Primary Trade Centers			
4A-F	All areas	Principal Arterials	Metro/Major Urban	55–65 mph
4A	Rural/Exurban/ Bypass	Principal Arterials	Metro/Major Urban	45–55 mph
4B	Urban/Urbanizing	Principal Arterials	Metro/Major Urban	40–45 mph
4C	Urban Core	Principal Arterials	Metro/Major Urban	30–40 mph
5	Minor Arterials			
5A	Rural/Exurban/ Bypass	Minor Arterials		45–55 mph
5B	Urban/Urbanizing	Minor Arterials		40–45 mph
5C	Urban Core	Minor Arterials		30–40 mph
6		Collectors		
6A	Rural/Exurban/ Bypass	Collectors		45–55 mph
6B	Urban/Urbanizing	Collectors		40–45 mph
6C	Urban Core	Collectors		30–40 mph
7	Special Access Plan			
7	All	All	All	All

B.2.2 Missouri

The Missouri method of roadway classification was developed based on the existing Missouri DOT functional classification system. The system remains unchanged except for the division of the principal arterial classification into two sub-classifications. All roadways that fall under Missouri DOT jurisdiction are classified according to this classification scheme. Cities and counties in Missouri control local roads and streets. The following Table B-4, along with a series of notes summarizes the categories of Missouri roadways (5).

Table B-4 Missouri Roadway Classification

Roadway Classification	Urban	Rural
Interstate/Freeway	U1	R1
Principal Arterial (A)	U2	R2
Principal Arterial (B)	U3	R3
Minor Arterial	U4	R4
Collector	U5	R5

- "Principal arterial (A) routes are key, non-freeway or non-interstate, intercity or inter-regional routes. They are intended to serve long-distance trips at relatively high speeds.
- The "collector" classification includes both major collectors and minor collectors.
- "U" indicates urban: the highway is within current urbanized or census urban area or is forecasted as urban within 20 years. Note: future urban highways should be planned as such in terms of access management.
- "R" indicates rural: the highway is not within a current or in a 20-year forecast urban area."

It should be noted that routes classified with a lower number are intended to carry long-distance, high-speed travel, stressing mobility, and strictly managing access. Routes classified as minor arterials and collectors comprise the bulk of the miles, serve more local destination traffic, and have a lower level of access control.

B.2.3 Washington

Access management standards such as spacing are determined based on a number of criteria including the functional class, future and present land use, environment and economic considerations, and highway design and operation. Roadways under access control are termed as limited access or access control highways and further as full, partial, or modified access control.

The use of the functional classification system for partial access control can be seen in Table B-5. This table also describes some general requirements for each of the functional classes that Washington controls.

Table B-5 Washington Partial Access Control Criteria

Item	Principal Arterial	Minor Arterial		Collector
Future Traffic Estimate (years)	20	20 (Urban and Rural)	20 (Rural Only)	20
ADT	Over 3,000	N/A	Over 3,000	N/A
Lanes Required	2	4	2	4
Min Route Length	Varies	Urban-2 miles Rural-5 miles Combination-3 miles		Points of design Change

B.3 Other Classification System

B.3.1 Florida

The Florida classification system consists of seven major classes with several subclasses within each class. They are assigned a numerical class where Class 1 includes interstates and freeways and Class 7 includes high accessibility roads in high-density areas. The classification in Florida is based on speed limits, median type (if a median exists), and accessibility (1, 6). Table B-6 summarizes the classification scheme used by Florida.

Table B-6 Florida Classification System

Class	Access	Sub-Classes	Speed	Median Type	Rural/Urban	Type of Travel/Roadways
Class 1	Limited Access (interstates, toll roads)	1a	N/A	N/A	U	fringe for cities in urban areas
		1b	N/A	N/A	U	existing urban areas other than 1a
		1c	N/A	N/A	U/R	trasitioning urban areas
		1d	N/A	N/A	R	rural areas
Class 2	High Control	None	N/A	N/A		system of existing or planed service roads
Class 3	Controlled	3a	> 45 mph	Non-Traversable	R	abbutting land has not been fully built out
		3b	< 45 mph	Non-Traversable	R	abbutting land has not been fully built out
Class 4	Controlled	4a	> 45 mph	Traversable	R	abbutting land has not been fully built out
		4b	< 45 mph	Traversable	R	abbutting land has not been fully built out
Class 5	Controlled	5a	> 45 mph	Non-Traversable	U	controlled acces, where abutting land is more developed than classes 3 or 4
		5b	< 45 mph	Non-Traversable	U	controlled acces, where abutting land is more developed than classes 3 or 4
Class 6	Controlled	6a	> 45 mph	Traversable	U	controlled acces, where abutting land is more developed than classes 3 or 4
		6b	< 45 mph	Traversable	U	controlled acces, where abutting land is more developed than classes 3 or 4
Class 7	Controlled	None	N/A	N/A	U	controlled acces, where abutting land is more developed than classes 3 or 4

B.3.2 Iowa

Iowa does not have a standard "classification" system that many other states have. However they define various types and groupings of roadways (7). From this, a rough classification system can be deduced as described in Table B-7.

Table B-7 Classification System for State of Iowa

Highway Type	Description
Priority I Highway	A primary highway constructed as a fully controlled access facility.
Priority II Highway	A primary highway constructed as a four-lane divided facility with a high degree of access control. Access to the facility is allowed only at interchanges and selected at-grade locations.
Priority III Highway	A primary highway constructed as a two-lane facility, a two-lane facility within a four-lane right-of-way corridor, or a four-lane facility. Access to the facility is allowed at interchanges and at-grade locations.
Priority IV Highway	A primary highway constructed as a two-lane facility; however, the definition may include a four-lane facility in an urban area.
Priority V Highway	A primary highway where access rights to it were acquired between 1956 and 1966, entrances were reserved at that time with no spacing limitations, and the department has subsequently determined that a higher degree of access control is desirable. The definition also includes a highway where access rights have not been acquired, but the department anticipates acquiring access rights in the future. Entrances to the highway are generally restricted to one entrance for contiguous highway frontage not exceeding 300 meters, two entrances for contiguous highway frontage exceeding 300 meters but not exceeding 600 meters, and so on
Priority VI Highway	A primary highway where the acquisition of access rights or additional access rights is not anticipated. This definition may also include a highway where access rights were acquired between 1956 and 1966, entrances were reserved at that time with no spacing limitations, and the department has subsequently determined that restricting access to the facility is o longer necessary. Access locations are approved based on safety and need.

B.3.3 Kansas

KDOT classifies all state roadways according to the level of importance of the corridor as defined in Table B-8 (8).

Table B-8 Kansas Roadway Classification

Route Classification	Description
A	All routes on the Interstate Highway System. These routes are to be protected by full access control.
B	This category applies not only to all B routes on the State Highway System, but also to all non-Interstate routes designated on the National Highway System regardless of route classification. Further, this category applies to all segments identified as “growth corridors” in the District Plan. These routes are to be protected by allowing for direct access only when alternative access is infeasible. When direct access is necessary, shared access will be required wherever possible. Minimum spacing of access points will be in accordance with the Access Spacing Criteria Chart. Such routes should be protected by purchase of access rights whenever feasible.
C	This applies to C routes not on the National Highway System and not designated as a “growth corridor.” Alternative access will be utilized wherever feasible, however, direct access is not an option of last resort, and should be utilized wherever it proves more effective. Shared access will be utilized wherever possible. Minimum access spacing will be in accordance with the Access Spacing Criteria Chart.
D	This applies to D routes not on the National Highway System and not designated as a “growth corridor.” These routes are to be protected by a modest level of management. Alternative access will be utilized whenever its convenience approximates that of direct access. Shared access will be utilized wherever possible. Minimum access spacing will be in accordance with the Access Spacing Criteria Chart.
E	All routes designated E. These routes are to be protected by a minimum level of management. Shared access will be utilized wherever possible. Minimum access spacing will be in accordance with the Access Spacing Criteria Chart.

B.3.4 Montana

The recommended access classification system in Montana is based on four principles:

- Reflect the diversity of Montana conditions,
- Build on functional classification,
- Keep it simple, and
- Ensure practical implementation.

The factors taken into consideration when deciding upon a classification system include:

- “Ensuring a balance between the intermediate and rural categories in terms of road miles.
- Recognizing that as development takes place in the intermediate category, it could eventually become developed.

- Taking care not to include the many agricultural, seasonal, and rarely used rural approaches."

The recommended classification system for Montana is as defined in Table B-9 (9).

Table B-9 Montana Classification System

Category/Functional Classification System	Undivided or Divided	Area
National Highway System (2,657 miles) (Non-Interstate NHS, principal arterials	Undivided (two-lane = 2,525 miles)	Rural – very low volume
		Rural
		Intermediate
		Developed
	Divided (non-traversable)	Intermediate
		Developed
Primary System (Minor arterials) (2,833 miles)	Undivided (two-lane = 2,779 miles)	Rural – very low volume
		Rural
		Intermediate
		Developed
	Divided (non-traversable)	Intermediate
		Developed

- Rural Very Low Volume – Roads that are forecast to have below 2,000 average annual daily traffic (AADT) in ten-year time.
- Developed Areas – Roads that include greater than 25 driveways (existing approaches) per mile (on either side).
- Intermediate Areas – They are the areas that are not developed and where MDT is concerned that development without attention to access management will significantly affect the performance and the safety of the system. They are thought of as the transition from developed to rural however, the boundary from developed is moving out toward the rural. The criterion for this category is greater than five and less than or equal to 25 driveways per mile.
- Rural Areas – Those areas that have an AADT greater than 2,000 in ten years and where there are no more than five "non-farm" approaches per mile. The adjacent land use would be agricultural or natural resource-based.

B.3.5 New Jersey

The NJDOT Access Management Code sets forth standards for driveways and other connections to and from state highways and establishes an access level for each segment of state highway. NJDOT defines seven access levels between public highways and activity centers, where the type of access permitted defines the various levels (10). This type of system is in contrast to those used by states such as Florida and Colorado, which assign a classification then identify the allowable access. The highest level of management, Level 1, includes freeways, while Level 7, encompasses frontage roads and local roadways. Rather than associate the levels with a specific functional class, a more refined system was developed utilizing the functional class, highway design features (such as a median), and the degree of urbanization (urban, suburban, rural). Tables outlining specifications for each of these characteristics are used by the appropriate jurisdiction to classify the segments. The seven primary access levels are as follows defined in Table B-10 (1, 10).

Table B-10 New Jersey Access Levels

Access Level	Description
1	Access only at interchanges
2	Access via at-grade public street intersections or at interchanges
3	Right turn access driveway only
4	Right and left turn access in, right turn access out
5	Right and left turn, in and out, left turn lane required
6	Right and left turn, in and out, left turn lane optional
7	Right and left turn, in and out, driveway spacing only limited by safety

B.3.6 Oregon

Oregon utilizes an urban/rural designation, which is further subdivided as follows:

"*Special Transportation Area (STA):* A highway segment is designated as a STA where a downstream, business district or community center straddles a state highway within an urban growth boundary. Traffic speeds are generally 25mph or less. STA's must be designated in a corridor plan and/or local transportation system plan and agreed upon in writing by ODOT and the local government.

Urban Business Area (UBA): A UBA is a highway segment designated where an existing area of commercial activity or future center or mode of commercial activity in a community. Traffic speeds are 35mph or less. UBAs must be designated in a corridor plan and/or local transportation system plan agreed upon by ODOT and the local government.

Commercial Center: A highway segment is designated a commercial center where there is an existing or expected center of commercial activity that may have more than 400,000 sq. ft. of leasable area (11)."

An example of how the classes are used is shown in Table B-11.

Table B-11 Oregon Access Management Spacing Standards

Posted Speed	Rural		Urban			
	Expressway	Other	Expressway	Other	UBA	STA
≥55	5,280	1,320	2,640	1,320		
50	5,280	1,100	2,640	1,100		
40 & 45	5,280	990	2,640	990		
30 & 35		770		770	720	
≤25		550		550	520	

B.3.7 South Dakota

The access classes used in South Dakota are primarily based on different levels of urban/rural designations, with separate categories for interstates and expressways. The classifications are set forth and updated periodically by the department. The access classes used by South Dakota are Interstate, Expressway, Free Flow Urban, Intermediate Urban, Urban Developed, Urban Fringe and Rural.

The following access classification definitions may be useful in understanding the Access Management Program outlined by South Dakota (12).

- *"Interstate* – the designated Interstate highway system, including I-90, I-29, I-229, and I-190.
- *Expressway* – high-speed divided highways serving interstate and regional travel needs.
- *Free Flow Urban* – higher speed facilities with access subordinate to through traffic movement.
- *Intermediate Urban* – serves through traffic while allowing moderate access density.
- *Urban Developed* – traffic artery with high access density. Access and through movement have equal priority.
- *Urban Fringe* – rural highway serving developing area immediately adjacent to a city or town. Access regulated to provide future through-traffic priority.
- *Rural* – low volume, high-speed facility. Access points are spaced for safety and operations efficiency".

B.3.8 Texas

The state of Texas has seven classification levels ranging from AC-1 intended to include high speed and high volumes of traffic to AC-7, which includes low speed, low volume traffic and high accessibility. The classes have a basis with the functional classification system, however, it is noted that a separate access classification system is necessary to apply the appropriate access management treatments. Therefore, the classification system was designed to reflect the following components- roadway purpose, land use, design features (median, lanes), location (urban/rural), and safety (crash rates and type) (1, 13). The following Table B-12 displays the access classification for Texas.

Table B-12 Texas Access Classification

Type	Speed	Median Type	Volume	Type of Travel/Roadways
AC 1	High	Non-Traversable	High	Includes interstate, interregional and enter city roadways, interstate highways, freeways, expressways.
AC 2	High	Limited Median Openings	High	Traffic over long distances.
AC 3	Med-High	Non-Traversable	Low	Areas with future development expected.
AC 4	Med-High	Traversable	Low	Areas with future development expected.
AC 5	Med-High	Non-Traversable	Med	Developed areas.
AC 6	Med-High	Traversable	Med	Developed areas.
AC 7	Moderate	Traversable/Non-Traversable	High	Urbanized areas.

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APPENDIX C ACCESS MANAGEMENT TECHNIQUES

In order to enforce access management a number of management techniques are used to regulate spacing and control. These techniques include signal spacing, spacing of unsignalized intersections, corner clearances, median alternatives, turning lanes, U-turns and frontage roads. Each of the techniques is described in greater detail in the following sections. In addition to the research findings, methods of calculating the impact of these techniques are also provided in the final section.

C.1 Traffic Signal Spacing

The performance of any highway is governed by the spacing of traffic signals. The gap between each signal combined with the number of signals on a given stretch has a significant effect on the operational performance of highways. Signals can account for a great deal of delay and increasing the number of signals along the road often can lead to more congestion. Signal use can be regulated by physical spacing or by designating a minimum bandwidth[*]. Colorado, Florida, and New Jersey require long signal spacing. Colorado and Florida require 0.5 mile signal spacing along principal arterial roads, while New Jersey requires a minimum through band of 50% of the signal cycle (1).

The guidelines for Uniform Signal Spacing as given in the Access Management Manual (2) are as follows:

(1) "A long uniform signal spacing is desirable and should take into account peak conditions.

(2) Uniform intervals should be used in major arterial-to-major arterial spacing. Deviations should be considered only in unusual situations.

(3) Shorter spacing at uniform intervals may be appropriate on minor arterials where lower progression speeds are acceptable.

(4) Minor cross-roads may deviate from the uniform interval when cross-road volumes are low or when the width of the cross-road approach is widened to provide for separate left turns, through movements, and right turns"

[*] Bandwidth is defined as the window of time available to a platoon traveling through an arterial.

Numerous studies have been completed on the effect of signal density. Cribbins collected data for 92 road sections in North Carolina and using multivariate regression models showed that total crash rates and injury crash rates increased as the number of intersections per mile increased (3). Studies by Squires and Parsonson in 1989 found that crash rates increase with signal density (4). It is evident that speeds increase directly as signal spacing increases and speed decreases with cycle length. Research indicates that each traffic signal installed per mile of roadway reduces vehicular speed by roughly 2 to 3 mph, while at the same time increases crash rates by about 4 percent. It has also been observed that as the first few traffic signals are introduced delay increases, but after a certain point, beyond the saturation number, the total delay remains constant (5). Researchers studied two corridors, Corridor I was a 7.5 mile, four-lane divided suburban arterial, and Corridor II was a 2.5 mile four-lane suburban arterial with a portion having a curbed median and another with a TWLTL. Simulations were run to determine the effect of the number of signals on the decay for each corridor. For Corridor I, the 5th signal was the first break point in the performance of the corridor over the 7.5-mile length. Corridor II (2.5 mile) showed a significant change in performance at the fourth signal. Installation of the 20th and the 10th signal for Corridor I and Corridor II, respectively, marked the number of signals where additional signals caused no change in the performance of the corridor. The critical number is dependent on a number of geometric and operational factors; therefore, these break point values are only valid for the particular sections studied. The conclusions of these studies indicate that long and uniform signal spacing are desirable in order to achieve efficient traffic signal progression at desired travel speeds.

C.2 Unsignalized Access Spacing

Access points are the places of conflict causing friction to the traffic stream. By increasing the space between access points, the number of conflict points can be reduced, thus increasing safety. Research has shown that the greater the access control, the lower the crash rates. Similarly, the greater the frequency of driveways and streets, the higher the number of crashes (6, 2).

Direct property access should be discouraged and adequate spacing should be established to maintain safety. Studies have shown that for every access point added to undivided highways the annual crash rate (crashes/MVMT) increases by an average of 0.15. Additionally, on highways with TWLTLs or non-traversable medians the crash rate increased by an average of 0.11. Additional access points also tend to increase the crash rates in rural areas. Research has shown that each access point added can increase the annual crash rate by 0.07 on undivided highways and 0.02 on highways with TWLTLs or non-traversable medians (1). Aside from the increased risk of crashes, operational factors also tend to be affected. For every 10 additional access points speeds can be reduced by 2.5 mph up to a 10-mph reduction for 40 access points per mile (2).

The unsignalized access spacing criteria recommended by the Texas Department of Transportation (TxDOT) indicates that the minimum criteria ranges from 1,320 feet for high speed AC2 (Access Class) roadways to a minimum of 155 feet for AC7 classification, depending on roadway conditions and design speed (7). These values are based on the minimum distance required to stop a vehicle according to stopping distance criteria outlined in the 2001 AASHTO Green Book (8).

C.2.1 Driveway Spacing Requirements

A key focal area of access management is driveway spacing. Similar to unsignalized access, speeds increase with increases in the separation distance between driveways. The deleterious effect of driveway traffic on arterial operations and on safety is well established by a number of studies including those completed in Denver, Oregon, and Florida (1). Much of the work has focused on driveway density impacts on safety or speed (9). Studies have shown that there is a 2-mph reduction in speed for every driveway added per 0.25 mile (10). Sight distance and desired signal progression also influence driveway spacing. Driveway spacing and minimum separation distances may vary widely from one community to another. Some communities apply driveway spacing requirements only on high priority corridors.

Local ordinances also are used in driveway spacing and are varied. For example, the access management regulations of Clarksville, Tennessee, particularly along State Route 374, permit one driveway or street intersection for every 660 linear feet of frontage. Additionally, the regulations require review and approval of proposed connection dimensions prior to issuance of a building permit. Similarly, in Clark County, Washington driveway spacing is tied to the posted speed limit along arterials and standards may be reduced to one-half the required distance for adjacent one-way driveways in Clark County (2).

Another approach is to provide variable spacing depending upon the land use intensity of the site served and of adjacent sites. Volusia County, Florida regulates the minimum distance between centerlines of two-way driveways on major thoroughfares (11). Driveways are grouped into four categories according to maximum average daily trips or maximum peak hour volume: minor, intermediate, major, and signalized. The minimum centerline spacing distance for these driveways is tied to the classification of the abutting driveways and ranges from 335 ft between two adjacent minor driveways, to 400 ft for two adjacent signalized or four lane driveways.

Driveway spacing standards can also be tied to particular zoning districts or land uses. Frederick County, Virginia, for example, establishes minimum driveway spacing standards along collectors and arterials for commercial and industrial zoning districts.

Good access management can be attained by proper placement of access points along with proper design of the access points. The more driveways present, the more driveway delay and queuing there will be. The first driveway of multiple subsequent driveways along a segment is the most important, since it produces the majority of the delay involved in sections with multiple driveways (9). This multiple driveway scenario may reduce driveway capacity as much as 30 to 50 percent.

C.2.2 Deceleration Lanes

Deceleration lanes at a driveway may improve the performance of the arterial roadway. A driveway without a deceleration lane causes an abrupt change in speed for vehicles turning off the arterial. This may result in an increase in crashes as well as delay for the section encompassing the driveway. A deceleration lane allows for separating through and turning vehicles and thus minimizes the potential rear end conflicts (9).

C.2.3 Single Lane Driveways

In locations where there are multiple single lane driveways, driveway capacity can be quickly reached in high traffic conditions. In some areas it may be feasible to add an additional lane to the driveway to increase its capacity. Allowing more lanes for the turning traffic into the driveway will also decrease the delay on the arterial caused by the multiple driveways (9).

C.2.4 Acceleration Lanes

The addition of an acceleration lane to driveways along an arterial roadway is beneficial to the driveway traffic. Acceleration lanes allow the traffic in an area to increase speed in order to more safely merge into the main flow of the arterial. Although adding acceleration lanes does not decrease delay for the through traffic, it does improve the safety of the roadway section. Allowing room for driveway traffic to speed up will eliminate the danger of extremely slow moving vehicles entering the traffic flow (12).

C.3 Access Separation at Interchanges

Interchanges are the connections for the traffic between freeways and arterial streets. These are points of activity in urban locations and also are the reason for a great deal of roadside development. If an intersection is too close to the arterial/freeway interchange, then it may cause heavy volumes, higher crash rates, and more congestion. Land development at interchanges should be sufficiently separated from ramp terminals in order to avoid heavy weaving volumes, complex traffic signal operations, frequent crashes, and recurrent congestion (9). The spacing should be such that it allows proper merging, diverging, and weaving of ramp and arterial traffic.

A 1968 study identified general principles that apply to most types of interchange development (13):

- "The most appropriate land use in the vicinity of an interchange area land (in terms of the regional economy) should be encouraged, and it should be consistent with maintaining an efficient and safe traffic facility.
- Land near interchanges should have sufficient depth to provide access to interior tracts and developments. Shallow frontages should be discouraged.

- Land use should be of a type that requires only a minimum number of access points and intersections along the arterial, particularly in the vicinity of ramp entrances and terminals.
- Development with frontage facing away from the arterial and onto service drives and local streets should be encouraged."

C.4 Corner Clearance

The corner clearance represents the distance between an intersection and the next access point along the roadway, either upstream or downstream of the intersection. Use of adequate corner clearances removes driveways from the functional area of at-grade intersections. "Inadequate corner clearances can result in traffic-operation, safety, and capacity problems. (1)" A number of specific problems as outlined by NHCRP 420 include (1):

- Through traffic blocked by vehicles waiting to turn into a driveway.
- Right or left turns into or out of a driveway (both on artery and crossroad) are blocked.
- Driveway traffic is unable to enter left-turn lanes.
- Driveway exit movements are impacted by stopped vehicles in left-turn lanes.
- Traffic entering an arterial road from the intersecting street or road has insufficient distance.
- The weaving maneuvers for vehicles turning onto an artery and then immediately turning left into a driveway are too short.
- Confusion and conflicts resulting from dual interpretation of right-turn signals

South Dakota discusses the importance of adequate stopping sight distances and adequate corner clearance at all intersections and driveway points. South Dakota corner clearance requirements are associated with particular speed limits. The corner clearance upstream of major intersections is provided in Table C-1.

Table C-1 South Dakota Minimum Upstream Corner Clearance

Speed (mph)	Corner Clearance (ft)
30	200
35	225
40	250
45	280
50	350
55	425

In addition to state regulations a number of examples of standards set by local governments for corner clearance are presented here:

Ingham County, Michigan corner clearances are determined as a function of the type of street that intersects. For example, if an arterial intersects another arterial then the clearance should be 250 feet, while the intersection of an arterial and a local road requires only 50 feet of clearance. Similarly the intersection of a local or a collector with any other roadway requires 50 feet of clearance. If a property line is located at a distance from the corner that does not meet the minimum requirements, then the driveway must be located within 10 feet of the property line away from the corner (14).

Austin, Texas corner clearance is determined as a function of driveway type, which is classified as Type I, II, and III. The access definition of Type I is one or two family residence. Type-II is any development other than in Type I and Type III is a temporary asphalt approach to parcels being used by any type of development, from a road not yet constructed or not having curb and gutter (14). Type I driveways require a clearance of 50 feet or no closer than 60% of parcel frontage. Type II and Type III driveways require a clearance of 100 feet or no closer than 60% of parcel frontage.

C.5 Median Alternatives

Medians are widely used for managing access along highways. Divided highways typically experience lower crash rates than undivided highways because they allow fewer opportunities for conflicts and erratic movements. They also provide a pedestrian refuge and have the potential to reduce pedestrian crashes.

Median treatments are a very good way to improve the access management of an urban arterial roadway. Raised-curb median treatments only allow access at key locations reducing the likelihood of left turn crashes with opposing through traffic. The problem with raised curb treatments is that the traffic turning left is "concentrated", and this may shift the rear end crashes to the access points. The introduction of turning bays is often associated with a reduction in rear end crashes.

Safety experience and a compilation of studies "suggest that the installation of TWLTLs or nontraversable medians, reduces crash rates by about 30 to 40 percent of those experienced with undivided cross sections that do not remove left turns from the through travel lanes (1)." It has also been shown that roads with raised medians are typically safer than roadways utilizing TWLTLs. Crash rates averaged approximately 5.2 and 7.3 crashes per million VMT, for the raised medians and TWLTLs, respectively. It is also noted that the effectiveness of medians varies for different locations, dependant on the roadway characteristics. Therefore, the crash rate values only provide information on potential results (1).

With the presence of medians it is often necessary to provide median openings periodically to allow for left turn or U-turn movements. An example of this is shown by the recommended minimum median spacing alternatives for directional and full medians for Texas. The recommendations include directional median openings from 1,320 feet for AC 2 and AC 3 to 330 feet for AC 7, and full median openings from 2,640 feet for AC 2 and AC 3 to 660 feet minimum spacing for AC 7 (7).

C.5.1 Two-way Left turn lanes

The first TWLTLs were installed in Michigan. They have been widely used as a means of improving traffic flow on 2-lane and 4-lane undivided roadways. For highway capacity purposes, roadways with TWLTLs are considered as divided highways and there is no need for free flow speed adjustment (15). TWLTLs also improve safety, reducing crashes by up to 34% when placed on a 4-lane undivided highway (16). The center lane also provides operational flexibility for emergency vehicles and reduces left turns from the through lanes.

C.5.2 Replacing TWLTLs with Nontraversable Medians

Like all medians, TWLTLs improve safety by removing left turns from through traffic. TWLTLs are typically used to provide access to "closely spaced, low volume commercial driveways along arterial roads." In terms of access management TWLTLs increase access opportunities rather than control access. Therefore, in order to better control access, the use of physical medians on 4 and 6 lane highways is preferred, since these types of medians are more capable of reducing conflict (16). However, there is a potential for increases in rear-end crashes at median openings if proper storage is not provided for the left-turning vehicles.

C.6 Left Turn Lanes

The main problems posed by left turns are increased conflicts, increased delays, and the complication of traffic signal timing (17). The potential for this problem is greater at major highway intersections. This problem is illustrated by the fact that more than two-thirds of all driveway related crashes involve left turning vehicles (18). Left-turn lanes are normally provided by offsetting the centerline or by recessing the physical median. The benefits from using left turn lanes include:

- Removal of the turning vehicles from the through travel lanes, reducing rear-end collisions and increasing capacity
- Improvement of the visibility of oncoming traffic for left turning vehicles.

The addition of left-turn lanes has been shown to be very cost effective. The removal of left turns from the through traffic lanes resulted in crash rate reductions ranging from 18 to 77 percent (19). The statistical median reduction was more than 50 percent. When left-turn lanes were introduced, there was a generally consistent reduction in rear-end and left-turn related crashes. Right angle crash rates declined at signalized intersections but showed mixed results at unsignalized locations (1). A Michigan study cited capacity gains of 20 to 50 percent as a result of a permitted two-phase signal operation. This two-phase signal decreases the stopped time for vehicles, thus decreasing the delay (20).

A great deal of research exists concerning the use of exclusive left-turn lanes. The 2000 Highway Capacity Manual (15) indicates that exclusive left-turn lanes at signalized intersections are appropriate in the following conditions:

- Where fully protected left-turn phasing is provided;

- Where space permits, left-turn lanes should be considered when left-turn volumes exceed 100 vph (Left-turn lanes may be provided for lower volumes as well on the basis of the judged need and state or local practice, or both); and
- Where left-turn volumes exceed 300 vph, a double left-turn lane should be considered.

In addition to the HCM recommendations, the following guidelines have been recognized when considering whether a left-turn lane is needed for signalized intersections (21). These guidelines were developed in Kentucky. Installation of a left-turn lane is recommended:

- Where there are five or more left turn related crashes within a year.
- Where the left-turn volume is greater than 50 vph and a delay analysis indicates that the left-turn delays exceed 30 sec/veh.
- At high speed, rural intersections for safe operations.

Similar criteria for unsignalized intersections were developed for conditions where a left-turn lane is recommended (21):

- Where there are four or more left-turn related crashes within a year.
- Where the left-turn volume is greater then 50 vph and the sum of left-turn and opposing volumes exceeds 800 vph for a two-lane highway or 900 vph for four-lane highways. A delay analysis should be undertaken to determine whether left-turn delay exceeds 20 sec/veh.
- Where a left-turn should be considered on divided roads with speed limits greater than 45mph.

Basic guidelines for left-turn lanes as given by TxDOT include the following (7):

- "Permissive-protected movements may be desirable where left-turn volumes range from 150 to 250 vph, speeds are less than 40 mph, and there are no more than two opposing through lanes.
- Permissive movements are appropriate where left-turn volumes are under 150 vph, speeds are less than 40 mph, and there are no more than two opposing through lanes.
- Protected movements are necessary where left-turn volumes exceed 200 vph and speeds exceed 40 mph".

Additional guidelines for when left-turn lanes should be provided are set forth in several documents for both signalized and un-signalized intersections (12, 22). Some guidelines that indicate a need for left-turn lanes include: the number of arterial lanes, design and operating speeds, left-turn volumes, and opposing traffic volumes.

C.7 U-Turns

To reduce conflicts and improve safety, U-turns are being used as an alternative to direct left turns. U-turn alternatives create about 50 percent fewer conflicts than direct left turns. Additionally, conflicts associated with direct left turns have the potential to be more severe (23). Reducing the number of conflicts decreases the crash risk for drivers (12). The U-turn makes it possible to prohibit left turns from driveway connections onto multilane highways and to eliminate traffic signals that would not fit into time-space patterns along arterial roads. According to several states that have used this practice, closing full median openings and replacing them with directional U-turns improves safety. Michigan has installed directional U-turn crossovers to accommodate indirect left turns for more than 20 years.

There is an increase in capacity and a reduction in delay when U-turns were provided as an alternative to direct left turns. A study by Koepke and Levinson (12), examining six and eight-lane roadways, found that the directional U-turn design provided about 14 to 18 percent more capacity than the left-turn lane designs. These gains in efficiency are mostly achieved on moderate to high-volume arterials, while they have little positive effect on low-volume roadways (24).

C.7.1 Safety Effects

The safety effects of U-turns have been examined through a number of different tests described below.

- In Florida, driveways left turns were replaced by right turn/ U-turn and crash rates were decreased by 22% (25).
- In Michigan, directional crossovers compared to bi-directional crossovers (unsignalized with opposing traffic) had a 14% reduction in crash rates (26).
- In Michigan, directional crossovers versus bi-directional crossovers (signalized with opposing traffic) showed crash rate reductions of 35 to 50% (26).
- Comparison of directional crossovers versus TWLTLS in Michigan resulted in a crash rate reduction of 50% (26).

C.7.2 Design Features for Michigan U-turn

Features for the Michigan U-turn, as given by the Michigan DOT access management manual are as follows (27):

- Two-phase signal operation at the major intersection where all left turns are prohibited.
- Directional U-turn crossovers for left turns located about 660 feet on each side of the signalized intersection. These may be coordinated with side streets and are sometimes signalized. (The signalized left turn eliminates cross weaves into the opposing traffic).
- Right-turn lanes on the artery and cross street.
- Left-turn lanes in the median of the artery for the U-turn crossovers.
- Coordination of signals in each direction of travel along the artery to ensure progression.
- Minor cross-street intersections that are unsignalized become two "T" intersections. Thus, there are no direct crossings of the median.

The required median width was based on field tests of various design vehicles. The directional crossovers require a 60-foot median to accommodate WB-50 trucks on a six-lane highway, or a 50-foot median on an 8-lane highway. If encroachment into an auxiliary right-turn lane is allowed, the required median width could be reduced by 10 feet. The desired location of crossovers is 660±100 ft from the signalized intersection. Additional crossovers may be provided at 660-foot intervals in urban areas or at 1,320-foot intervals in rural areas. In urban areas in some states where major developments occur frequently, mid-block back-to-back directional crossovers are sometimes constructed to service these developments and to minimize travel time. In Illinois, the spacing between such mid-block crossovers is set at 150 feet (100-foot minimum) (13).

C.8 Roundabouts

Roundabouts are considered an alternative solution for intersection design that could reduce the number of conflict points. Roundabouts have been used extensively in several countries and several have been introduced recently in the US. Roundabouts reduce the number of conflicts at a typical four-leg intersection by 75 percent: from 32 potential conflict points at an unsignalized intersection to 8 points. Roundabouts are considered a very safe form of intersection design and recent studies have documented the savings from their installation. A recent study for roundabouts in Maryland showed a decrease in crashes between 18 and 29 percent and a reduction in injury crashes between 63 to 88 percent (28). Another study of roundabouts in several US locations demonstrated a similar reduction in crashes (29). This study showed a 51 percent reduction in crashes accompanied by a 73 percent reduction in injury crashes. The study showed similar reductions for both urban and rural locations, as well as intersections converted from either stop control or signals.

As the studies above indicate, large reductions in severe injury crashes have been observed after the installation of roundabouts. However, there are a few issues that should be pointed out here. First, even though there are significant reductions of severe crashes, the reduction in the overall number of crashes is sometimes not as large. Second, most of these sites were not signalized intersections, and thus the safety gains at signalized intersections may be lower, since there is the likelihood of higher safety levels at such intersections. Third, there may be significant differences in the level of safety gains between urban and rural areas due to the differences in travel speeds. Finally, there are significant differences in the safety gains realized among the various types of road users, with passenger car users having the highest gains while pedestrians and bicyclists have the lowest. Overall, though, these data demonstrate a safety improvement from roundabout installations.

These facilities can also improve intersection capacity over signalization. Roundabouts with single lane approaches seem to perform very well with volumes of up to 2,500 vehicles per hour due to their simplicity (30). Simulation studies have also shown significant improvements in capacity and reduced delays (30). Additionally, a study of eight US roundabouts showed that delays were reduced after the conversion of the all-way stop control to a roundabout (31). Roundabouts are particularly successful where the traffic flows are in balance on all approach legs.

C.9 Frontage Roads

Frontage roads reduce the number of connections to main line roadways thus reducing the frequency and severity of conflict points along the main travel lanes. Direct property access is provided through the frontage road.

Recommended guidelines for frontage road installation include (2):

(1) Frontage roads for retrofit situations should operate one-way, while using merging maneuvers to enter and exit the main lanes.

(2) The separation between the major road and the frontage road at crossroads should be at least 300 ft; 150 ft is the absolute minimum and should be used only where frontage road volumes are very low.

(3) A minimum 25 ft landscaped separation should be required between the major roadway and the frontage road.

(4) The reverse frontage service road design is preferred over the traditional frontage road.

(5) Pedestrian and bicycle movements should be accommodated on the frontage road or service road.

(6) Parking on a frontage road or service road should be prohibited except in residential areas.

The use of frontage roads along arterials that connect with freeways can reduce left turns and weaving, avoid double loading of arterial roads, and improve property access. Additionally, frontage roads allow public agencies to have complete control of access to the arterial and can accommodate parking maneuvers and loading if necessary. In order to effectively utilize a frontage road, the design must address the potential effects at any major crossroad intersection. This becomes increasingly important "when the distances between the frontage road and arterial are short, the intersections are signalized, and the storage distances on the crossroad are inadequate (1)." Another potential problem may arise if commercial development occurs along frontage roads. This may result in increased traffic volumes that may create congestion and increase the potential for crashes due to the overlapping of maneuver areas, close conflict points, and the complex movements needed to enter and leave the main travel lanes. Therefore, great care must be taken in the design of arterial frontage roads to protect both the arterial and crossroad operations (13).

C.10 Impact Calculator

The Impact of Access Management Techniques (IAMT) Calculator (30) provides a set of tools to calculate the effects of changing access conditions along a section of highway by using the applications developed in NCHRP Report 420 (1).

The calculator quantifies the impacts of access management techniques and decisions for specified conditions. Input information is required to describe the general characteristics of the project, and IAMT uses this information to compute impact measures for five analysis types:

- The *Signalized* analysis estimates the effect of changes in traffic signal density on arterial travel times and speeds.
- The *Unsignalized-Safety* analysis estimates the effect of access conditions and decisions (e.g. access spacing/density and median type) on the crash or accident rate.
- The *Unsignalized-Operations* analysis estimates the effect of right-turns into unsignalized driveways on through traffic conditions based on the access density, the right-turn volume, and the segment length. This analysis reflects the interference caused by multiple access points. The Unsignalized-Safety analysis should be done before working on this analysis as some results are shared.
- The *Interchange* analysis estimates the access separation distance needed along interchanging arterial roadways between a ramp and cross street.
- The *Economic Impact* analysis estimates the maximum economic effects resulting from median closures and limiting certain access points to right turns only.

C.11 Key Findings

The access management techniques reviewed indicates that there are a variety of methods that could be used to control access and promote efficient traffic flow. However, there are two basic techniques that are central to a successful access management plan. These are intersection spacings, whether signalized or unsignalized, and left turn treatments. The frequent interruptions of flow by any type of intersection can be detrimental both to safety and operation of the roadway. Optimum spacing of signalized and unsignalized intersections provides minimal disturbances of flow and a reduced number of conflict points. Proper spacing between signals and unsignalized intersections in the form of corner clearances also aids in reducing conflicts and improving flow.

Another essential component is the handling of left turns to and from the access points, either as direct turns or U-turns. Integral to this choice is the presence and type of median because of the impact that medians have on these turns. Non-traversable medians are the most effective treatment for eliminating conflict points.

These two elements are fundamental to a successful access management system and guidelines for each are required to be established for each access class.

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